DEFENSE AR JOURNAL

A Publication of the Defense Acquisition University

ISSUE 53 | January 2010 | Vol. 17 | No. 1

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **JAN 2010**	2. REPORT TYPE	3. DATES COVERED **00-00-2010 to 00-00-2010**

4. TITLE AND SUBTITLE **Defense AR Journal, Vol.17, No.1, Issue 17**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Defense Acquisition University,ATTN: DAU Press,9820 Belvoir Rd., STE 3,Fort Belvoir,VA,22060**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**171**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

The *Defense Acquisition Review Journal*, formerly the *Acquisition Review Quarterly* journal, is published quarterly by the Defense Acquisition University (DAU) Press. Postage is paid at the U.S. Postal facility, Fort Belvoir, VA, and at additional U.S. Postal facilities. Postmaster, send address changes to: Editor, *Defense Acquisition Review Journal*, DAU Press, 9820 Belvoir Road, Suite 3, Fort Belvoir, VA 22060-5565. For free copies, mail written requests with an original signature to the above address using the subscription form provided in this journal. Some photos appearing in this publication may be digitally enhanced. ISSN 1553-6408.

The ***Defense Acquisition Review Journal***
is available electronically on the DAU Home Page at
http://www.dau.mil/pubscats/Pages/ARJ.aspx

DEFENSE ARJ JOURNAL

A Publication of the Defense Acquisition University

The ***Defense Acquisition Review Journal (ARJ)*** is a scholarly peer-reviewed journal published by the Defense Acquisition University (DAU). All submissions receive a blind review to ensure impartial evaluation.

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This article explores concerns about the mid-1990s Acquisition Reform notion of partnering with industry. Design Agent, Lead Systems Integrator, and Total System Performance Responsibility roles were conveyed to companies charged with system design, technology development, and funds allocation, while balancing cost, schedule, and performance goals for program success. Although these arrangements arose from noble intentions, recent critics have posited that they have driven cost growth and have weakened DoD's ability to coordinate and control acquisition programs. The author infused real-world phenomena with elements of economic transaction cost theory and network theory to make recommendations about future optimization of roles.

45 **Achieving Outcomes-Based Life Cycle Management**
Lou Kratz and Bradd A. Buckingham

Over the course of 60 years, DoD has attempted to improve its acquisition and life cycle process through a series of incremental changes to address requirements creep, cost growth, funding instability, and technical risk. Unfortunately, these innovations have not improved cost, schedule, or technical performance of DoD programs. Currently, the United States faces significant economic and national security threats from near-peer competitors, rogue states, and transnational terrorist organizations. This multiplicity of threats requires an agile, cost-efficient process to mature and sustain military capabilities. This article explores fundamental changes needed within government and industry to evolve a highly agile and responsive life cycle process.

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After three years of parallel research and application efforts aimed at enabling pre-Milestone A cost analysis, the time investment has produced dividends of progress and lessons learned for a team of Army researchers. Clearly, early acquisition investment decisions must be cost-informed, and the demand for this early cost information is growing. Although concrete tools are being developed to enable the analysis to support early investment decisions, it will not be achievable without an analysis culture with the policy, procedure, and willingness to develop and/or accept cost estimates that are less precise than those developed at Milestone B or Milestone C. Making early analysis a reality will require large-scale, department-wide culture change within and around the analysis community.

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This article examines the legislation leading up to the Small Business Act of 1953 and the resulting implementation of congressionally mandated small business goals; industry's support of small business initiatives; government oversight of small business plans; and the sometimes improper interpretation of rules and regulations affecting the Small Business Program (SBP). The combination of mandated goals, improper interpretation of regulations, and the resulting negative effect on large businesses may, as supported by the author's research, be significant factors in the program's demise. Also included are suggestions on how the federal SBP can become a viable program that benefits small businesses so they truly receive an equitable share of government dollars without infringing on supply chain initiatives of large business contractors.

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This article examines the evolving model used to describe the systems engineering process in Defense Acquisition University (DAU) courses. As implied in the title, discussion topics reflect both the legacy and current focus of systems engineering within the Department of Defense (DoD). The first two sections provide a historical context of the systems engineering discipline and outline the evolution of process models and terminologies used to describe process activities within DoD. The last two discussion sections describe interactions among the technical processes and technical management processes, and analyze the implications of systems engineering terminology changes introduced with updates in defense acquisition guidance released in June of 2009.

111 **Open Systems: Designing and Developing Our Operational Interoperability**
MAJ James Ash, USA (Ret.) and LTC Willie J. McFadden II, USA (Ret.)

The need for technological innovation in the U.S. Army is continually increasing. The challenge is to institute a "change paradigm" that will allow the incorporation of new technology into existing systems to address current and future challenges, within fiscal and technological constraints. Open Systems is such an approach. An Open Systems environment facilitates a more efficient assimilation of technology. Furthermore, Open Systems would reduce the costs of technology integration and encourage efforts toward integrated training and operational readiness, using standards and protocols across our nation's warfighting enterprise. Various goals and challenges are inherent to the use of an Open Systems approach, such as Transformation Life Cycle, interoperability, physical connectivity, and political and technical solutions, which are described herein.

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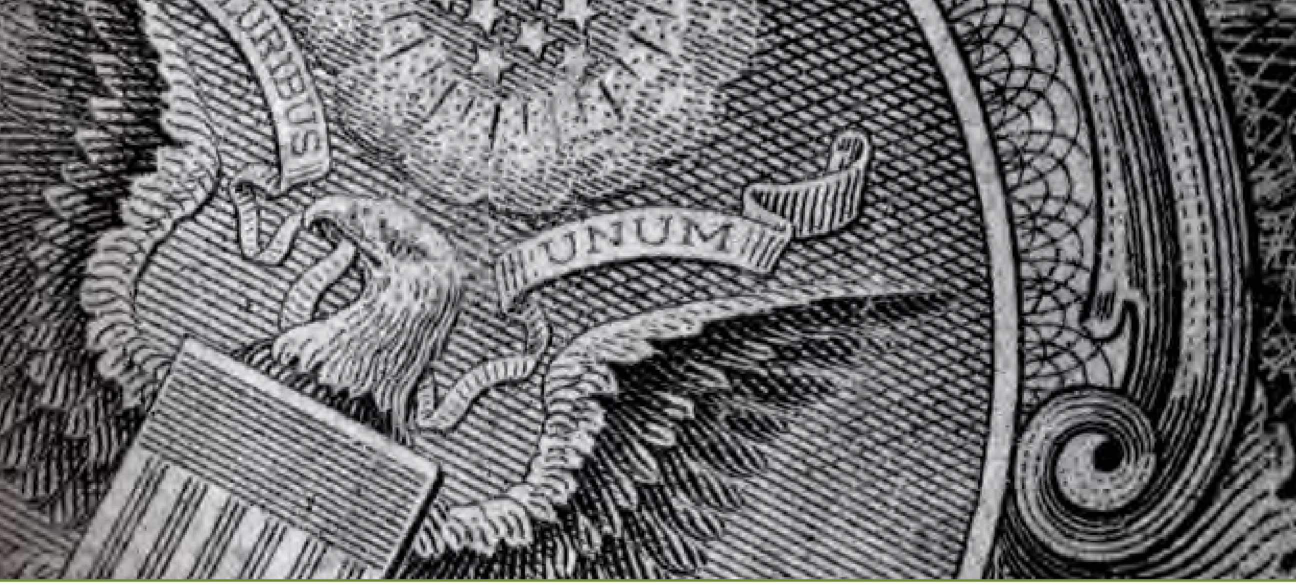

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JoAnn McCabe and Col John Wissler, USAF

The Air Vehicles Directorate of the Air Force Research Laboratory, concerned that its scientists and engineers (S&Es) were spending more time on nontechnical duties than on technical duties, developed a Web-based means of gathering data on this issue. After almost 27,000 hours, recorded data showed approximately 19 of 40 hours in an average week were spent on technical taskings. This led the directorate to examine various ways of increasing the share of technical time productivity reported by its S&Es. This article highlights the authors' data gathering results and offers insights on increasing the technical and value-added time of S&Es, thereby resulting in increased productivity for AFRL—an important Air Force resource.

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Mark Oehlert

The hardest part about implementing "Web 2.0" or "Social Media" within the defense acquisition workforce is not acquiring new technology, successful change management, or organizational design. The most difficult challenges confronting users of this new technology are not monetary, functionality, or even integration; rather, the most difficult challenges are difficult questions about how the workforce regards the dynamics of fear, control, and trust within their own organizations. Can these very human questions be answered in a manner that most fully exploits the capabilities that are now open to the acquisition workforce? In this article, the author seeks to answer that question and provide insight and close examination of this new 21st century phenomenon called Web 2.0.

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REMARKS

FROM THE EXECUTIVE EDITOR

I am pleased to present Issue 53 of the *Defense Acquisition Review Journal.* We have an exciting and diverse line-up of articles covering a variety of relevant topics for the acquisition community. In the first article, "Command Post of the Future: Successful Transition of a Science and Technology Initiative to a Program of Record" by BG Harry Greene, USA, Larry Stotts, Ryan Paterson, and Janet Greenberg, the authors examine the transition of Science and Technology (S&T) into existing acquisition programs. Historically, only about 25 percent of all S&T programs successfully transition to development and acquisition. One of the major issues is the lack of sufficient technical maturity. Immature technology often causes cost growth and schedule slips while the program manager tries to address this problem during the development cycle. The DoD 5000 series re-write in 2000 shows DoD's clear intent to improve technology insertion into the acquisition process. As a part of this change, it was recognized that technical maturity must be addressed up front and adequately tested before transitioning, but often this was not done. This article outlines how the CPOF program was successfully transitioned from the Defense Advanced Research Projects Agency to the U.S. Army using a tailored acquisition strategy that allowed the new CPOF technology to be fielded as a technology insertion to the Army Battle Command System of Systems. Key to the success of this transition was the use of robust risk management, early and sustained user feedback, stable funding, and honest and open communication between all stakeholders. This acquisition strategy was an evolutionary approach, tailored to address the risk areas over time rather than trying to develop the perfect product in the first delivery.

The second article, "Lead Systems Integrators: A Post-Acquisition Reform Retrospective" by Kathlyn Hopkins Loudin, addresses concerns about the mid-1990s Acquisition Reform initiatives, which embraced the philosophy of "partnering with industry." This philosophy led to business relationships with various titles throughout DoD. The "Lead Systems Integrator" (LSI) concept was most used by the Army. Correspondingly, the "Design Agent" concept was used in the Navy, and the "Total System Performance Responsibility" (TSPR) was very popular in Air Force contracts. These concepts were the result of a series of laws, policies, reforms, and initiatives embracing the Acquisition Reform movement of the 1990s. A key assumption of all these concepts was that cost-efficiency could be improved by using contractors more effectively and giving them more powerful roles. The general result of all these business models was to shift more systems development and systems engineering work to the

private sector. While this approach has some advantages, it also resulted in a de-emphasis of organic systems engineering capability within DoD. Recent critics have asserted that these concepts have driven cost growth and have undermined DoD's ability to control major acquisition programs. However, the data suggest that the use of LSI strategies is not, by itself, a good predictor of cost growth. The author analyzes these concepts and makes recommendations about future optimization of these types of roles.

The third article, "Achieving Outcomes-Based Life Cycle Management" by Lou Kratz and Bradd A. Buckingham, explores fundamental changes needed within government and industry to evolve a highly agile and responsive life cycle process. For decades, the Department of Defense has attempted to improve its acquisition and life cycle process through a series of incremental changes to address major challenges, such as requirements creep, evolving threats, cost growth, funding instability, and technical risk. Unfortunately, these changes have not met expectations. Currently, the United States faces significant economic and national security threats from rogue states and transnational terrorist organizations. DoD acquisition and life cycle sustainment processes are straining under the demands of the Global War on Terror and an emerging shortage of skilled acquisition and sustainment professionals. Cost/schedule growth, extended development cycles, schedule delays, elongated logistics response times, and increasing backorders are evidence of those strains. These threats and challenges require an agile, cost-efficient process to mature and sustain military capabilities. This article addresses fundamental changes needed within government and industry to evolve a highly agile and responsive life cycle process.

The fourth article, "Pre-Milestone A Cost Analysis: Progress, Challenges, and Change" by Martha "Marti" A. Roper, deals with one of the most challenging and most important issues early in the acquisition cycle—effective cost estimating and cost analysis. As a result of the 2004 Quadrennial Defense Review's emphasis on earlier investment decision making, the Office of the Under Secretary of Defense (Acquisition, Technology, & Logistics), sponsored a study to examine the opportunities to improve early cost estimating in acquisition programs. A team of Army analysts at the Office of the Deputy Assistant Secretary of the Army for Cost and Economics conducted the 3-year research study resulting in some important lessons learned. Clearly, the biggest challenge was how to develop cost estimates so early in the life cycle, with so little system definition. The analysts found three major elements that enable pre-Milestone A cost estimating. The first is an analysis framework that can make use of qualitative capability data to produce a cost estimate. The second is a cumulative high-level cost data source that links systems to their

REMARKS FROM THE EXECUTIVE EDITOR

capability sets. The third is an analysis culture with the policy, procedure, and willingness to develop and accept cost estimates that are less precise than those developed at Milestone B or Milestone C. This research makes the case that Pre-Milestone A cost analysis can be the foundation upon which sound investment decision making is built.

The fifth article, "The Demise of the Federal Government Small Business Program" by Philip G. Bail Jr., traces the history of federal government interaction with small businesses in the United States and offers a warning that the current state of small-business setaside is unsustainable. The author presents a comprehensive summary of federal policy and legislation beginning with the Herbert Hoover administration in 1929. The DoD became directly involved in this issue by the creation of the Armed Services Procurement Act of 1947. The author discusses how numerous laws and public policy decisions regarding small business policy have been implemented by the federal government and DoD. Despite many efforts, the government's attempts to increase small business's share of federal contracts have not been totally successful. The author offers recommendations and suggestions on how the federal small business program can become a viable one that benefits small businesses so they truly get an equitable share of government dollars.

The sixth article, "Building on a Legacy: Renewed Focus on Systems Engineering in Defense Acquisition" by Mary C. Redshaw, provides a historical context of the systems engineering discipline in DoD, outlines the evolution of process models and terminologies, and analyzes the implications of terminology changes recently introduced in the Defense Acquisition Guidebook (DAG) released in 2009. Because of DoD's role in developing and acquiring large and complex systems, defense acquisition managers initially led the effort to formalize the systems engineering process by publishing Military Standard 499 (MIL-STD-499) in 1969. This baseline documented the first formal consensus standard governing the systems engineering community of practice. There have been many iterations and changes in how systems engineering is viewed and applied throughout the DoD and the defense industry since 1969. Redshaw expertly navigates the reader through the evolution of these changes in process and philosophy.

The seventh article, "Open Systems: Designing and Developing our Operational Interoperability" by MAJ James Ash, USA (Ret.) and LTC Willie J. McFadden II, USA (Ret.), makes a case for the growing importance of using an Open Systems approach in defense systems due to today's complex threat environment and interoperability needs. The authors examine the attributes of an open systems approach to technology insertion and operational readiness. Due to the changing nature of warfare

and increased operational demands, the need for technological innovation is continually increasing; however, insertion of technology brings additional problems and constraints (fiscal, technological, and logistical challenges) that must be addressed. The authors argue that a possible solution to incorporating new technologies into current systems is to intensify efforts to achieve a true open systems environment.

The eighth article, "A Time Study of Scientists & Engineers (S&Es) in the Air Vehicles Directorate" by JoAnn McCabe and Col John Wissler, USAF, addresses the issue of how much time government scientists and engineers actually spend doing technical work, as opposed to other bureaucratic, non-technical work. This article resulted from a case study done at the Air Vehicles Directorate of the Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base, where about 600 people are employed. Approximately one-third of these are S&Es who develop advanced flight vehicle technologies in the areas of aerodynamics, flight control, and structural sciences. These technologies can be found in virtually every major weapon system in the Air Force. In response to budget cuts and efficiency reforms, the workforce in the Air Vehicles Directorate has declined 16 percent in the last decade. Many of these cuts resulted in the reduction of non-technical personnel, often leaving additional non-technical work tasks to the S&Es. Concerns have been raised to leadership that the technical workforce is not accomplishing enough technical work. Therefore, the questions for AFRL are: 1) How much real technical work are the S&Es doing? and 2) Is this the right mix? This article summarizes the initial time study completed at the Air Vehicles Directorate and provides several leadership initiatives intended to address this situation.

The final article from the Defense Acquisition University (DAU) Technology Corner is written by DAU's resident historian, social anthropologist, and technologist Mark Oehlert. Oehlert works in the Global Learning Technologies Center at the DAU. His duties focus on the use of social media in acquisition workforce education and development. He offers a thought-provoking piece providing insight on how to address the challenges of introducing new technologies and communication opportunities within an organizational culture.

I hope you will enjoy this issue as much as we enjoyed putting it together.

Dr. Paul Alfieri
Executive Editor
Defense ARJ

DEFENSE ACQUISITION REVIEW JOURNAL

ISSUE 53 JANUARY 2010 VOL. 17 NO. 1

COMMAND POST OF THE FUTURE: SUCCESSFUL TRANSITION OF A SCIENCE AND TECHNOLOGY INITIATIVE TO A PROGRAM OF RECORD

BG Harry Greene, USA, Larry Stotts, Ryan Paterson, and Janet Greenberg

This article outlines how the Command Post of the Future (CPOF) program was successfully transitioned from the Defense Advanced Research Projects Agency (DARPA) to the U.S. Army. Use of a tailored DoD 5000 acquisition strategy allowed the new CPOF technology to be fielded as a technology insertion into the Army Battle Command System (ABCS). Key to the success of this transition included the use of risk management techniques to drive the program forward, use of early and sustained feedback from the user community, maintaining transition funding stability, and honest and open communication between all stakeholders. The DoD 5000 acquisition strategy was tailored to fix the risks over time, rather than trying to develop the perfect product in one delivery.

Keywords: *Command Post of the Future (CPOF), Battle Command, Science and Technology (S&T) Initiative, Risk Management, Tailored Process, Army Battle Command System (ABCS)*

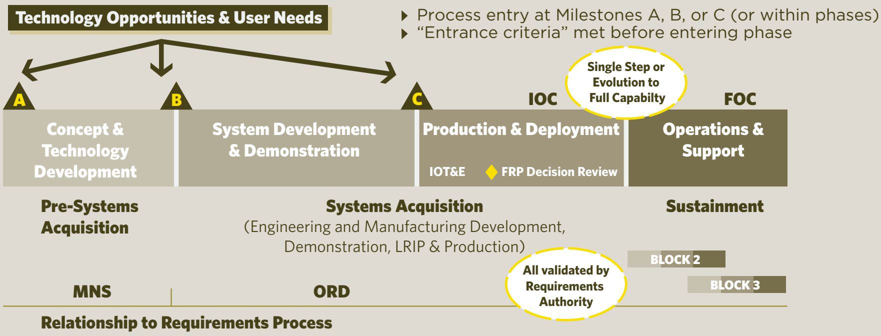
image designed by Harambee Dennis »


CPOF
Command Post of the Future
Collaboration at the thought process level.

Background

In 1999, Under Secretary of Defense for Acquisition, Technology, and Logistics Jacques Gansler tasked [then] Director, Defense Research and Engineering (DDR&E) Hans Mark to find out how many Service Science and Technology (S&T) programs make it from research into development and acquisition. This tasking was part of the under secretary's effort to develop a plan for Acquisition Reform. After conducting a comprehensive workshop, the participants determined that for all the Services only about 25 percent of all S&T programs transitioned. One of the major issues was technical maturity of the S&T results, which often caused cost growths and schedule slips while the program manager tried to fix problems during the development cycle. The result was a complete rewrite of the 5000 series (Department of Defense, 2000), as illustrated in Figure 1, which clearly shows that S&T products can be inserted throughout the entire process. The intent was to get more products transitioning from the S&T community to acquisition programs.

FIGURE 1. DEVELOPMENT AND ACQUISITION PROCESS (AS OUTLINED IN DOD 5000.2)



As part of this new process, the rewrite team recognized that technical maturity must be addressed up front. Usually, technology was not tested thoroughly; rather, it was often transferred to acquisition without knowledge of how well the technology worked or what improvements were needed to build a reliable product. In response, the minimum entrance requirement for any S&T products at Milestone (MS) B was a Technology Readiness Level (TRL) 6. The TRL 6 entrance criterion for Milestone B was chosen because it provided the government with confidence that the proposed technology would not require multiple test cycles. This requires some developmental-like testing prior to MS B, as well as some Limited User Tests (LUTs) to minimize risk.

This article outlines how the CPOF program was initiated, executed, and transitioned. By documenting our experiences, we hope to provide

the research, development, and acquisition communities an example of best practices that actually worked. Specifically, we seek to show readers how to successfully transition S&T products to create new capabilities for the Army of the future.

WHAT IS CPOF?

Command Post of the Future is a planning and mapping tool intended for collaboration between multiple echelons in a tactical environment (Myers et al, 2002, pp. 343–348). In 1997, the Defense Advanced Research Projects Agency (DARPA) began developing the CPOF, using a team of retired senior officers and experts in cognitive psychology, human-computer interfaces, and computer technology. The team developed the CPOF as a commander-centric software environment. CPOF is an intuitive and easy-to-learn system that supports 2D and 3D visualization that can be uniquely tailored to suit the user's individual requirements. It was specifically developed to enable distributed, collaborative, command and control, rather than simply allowing applications to share information. CPOF supports deep collaboration—collaboration at the thought process level that literally allows commanders, subordinates, and key battle staff to see what the commander is thinking.

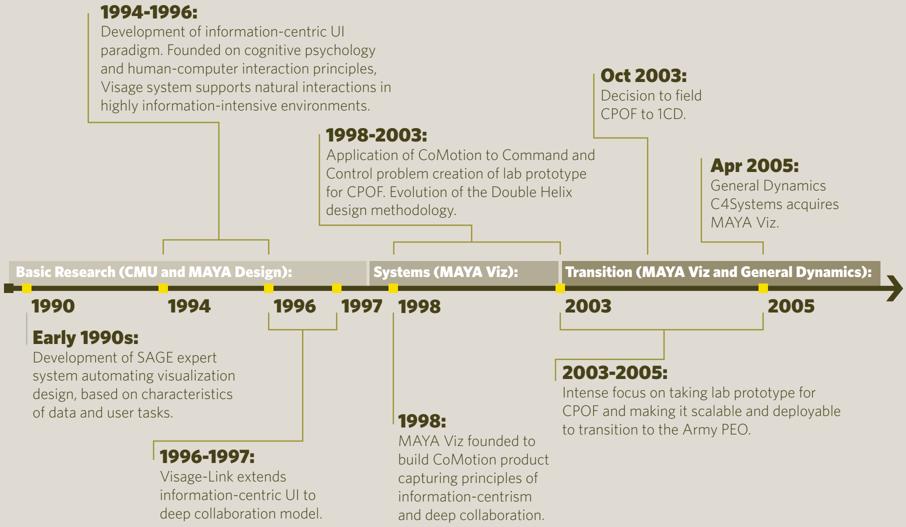
CPOF integrates government-developed software with Commercial-Off-The-Shelf (COTS) software to provide a workspace tool containing various frames such as charts, tables, and customized appliances specific to the application. Further, it supports parallel, synchronous and asynchronous, cross-functional planning and execution; and provides for bi-directional interoperability with Army Battle Command System (ABCS) and other Department of Defense (DoD) systems.

The sharing and collaboration of intelligence and other information via voice and visualization techniques, within a distributed architecture, is also supported by CPOF. It also provides the capability to simultaneously collaborate and share data and information horizontally among operators at the same echelon and vertically between operators at other echelons in real-time. The ability to collaborate among analysts at an echelon, between echelons, and with battalions is key to achieving information dominance. And information dominance is critical to the ability of the CPOF systems to provide the warfighting commander with an enhanced local and multi-echelon situational awareness, which promotes synchronized operational planning and execution.

PROGRAM HISTORY IN DARPA

Figure 2 shows an overview of the history of the CPOF program. It started in the early 1990s as a research effort on expert systems design. Development continued under the auspices of DARPA, concentrating on the

FIGURE 2. HISTORY OF CPOF PROGRAM



design of a user interface that would be intuitive in an information-intensive environment like that found in tactical Army Command and Control.

The history of CPOF at DARPA is broken out into four very distinct phases, which were led by three different program managers; the program endured at DARPA from 1997 until it fully transitioned to the Army in 2006.

During the initial phase of the program, DARPA invested in exploring rich display technologies, artificial intelligence agents, learning technologies, and inference engines. This phase looked toward the future command post—a high tech theater where commanders would be assisted by intelligent agents in making battlefield decisions, and where holographic and high resolution displays would turn the Tactical Operations Center (TOC) of today into a command theater.

With Phase I complete, DARPA received some very specific guidance from senior officers in the Army and Marine Corps about the efforts to create a high tech command theater. During this phase, retired military advisors led technologists through a series of decision support exercises, including field exercises. The intent of this phase was to bring military operators and technologists into the same environment, creating an atmosphere where the technology and operations could co-evolve.

The CPOF interface was developed and refined during the third phase of the program. Working in conjunction with the Marine Corps Warfighting Lab and active duty units from the Army and Marine Corps, a unique development environment was created. It tightly coupled operators and technologists as they explored the possibility of radical changes in the way operators perform their jobs with new technologies.

In the fall of 2003, CPOF was introduced to [then] MG Peter W. Chiarelli, USA, commander of the 1st Cavalry Division (1CD). MG Chiarelli requested that CPOF deploy with his division to Iraq. In this phase—42 systems and servers—a team of technical and operations subject matter experts were deployed in-theater. In March of 2004, working with MG Chiarelli, the DARPA team deployed systems throughout the division headquarters and to each of the brigade headquarters. The deployment team was able to work with operators to incorporate CPOF into part of their daily battle rhythm.

With the early success of CPOF and its deployment with 1CD, an agreement was codified in a Memorandum of Agreement (MOA) between DARPA and the Department of the Army. This agreement called for continuing the deployment of CPOF to Iraq as an experiment, and furthering the experiment by fielding CPOF to two additional divisions in subsequent years. It also provided for a subsequent decision on transition of CPOF to an Army Program of Record (POR). Transition was dependent on three measures:

- The ability to scale CPOF to 200 users
- Demonstration of the use of CPOF over standard tactical communications
- Demonstration of interoperability with the ABCS.

OPERATIONAL, TECHNICAL, AND PROGRAMMATIC COLLABORATION

With the 1CD deployment into Iraq underway, a collaborative effort between DARPA and the Army began in earnest. DARPA's efforts to date had been focused on creating the most intuitive collaborative interface. Very little work had been conducted to harden the system for operations in a tactical environment. Together, a team that included a Marine Corps program manager from DARPA, soldiers from the Army's Training and Doctrine Command (TRADOC) and 1CD, and acquisition professionals from PEO C3T (Program Executive Officer, Command, Control, and Communications–Tactical) and Army G-8, worked to put in place a 2-year plan to cover operational, technical, and programmatic concerns. Senior leadership of the division took ownership of the test-fix-test process, allowing warfighters to dictate the requirements. MG Chiarelli understood the technical issues that needed to be conquered, and was willing to accept the risk to see CPOF successfully integrated into the division.

In parallel with MG Chiarelli's use of CPOF in-theater, the Army and DARPA decided to look at how best to continue CPOF development. DARPA and the Army came to an agreement, documented in the 2004 MOA. DARPA would continue to fund the advanced technology research needed to harden the system and exploit technical lessons learned. The Army would fund the operational support and hardware procurements

necessary to execute the continued fieldings. During this collaborative phase of the program, DARPA provided $13.5 million of funding, and the Army provided $37.5 million. DARPA would maintain primary control of the program for 2 years. The MOA also called for CPOF fieldings to three Army Divisions (Operation Iraqi Freedom 2 through 4) and technological improvements to CPOF software in the areas of scaling, satellite communications, and ABCS integration.

Some hurdles, however, needed to be overcome—none of which were insignificant in the way the acquisition community procures new systems.

- DARPA's involvement with and funding of CPOF was scheduled to end at the conclusion of the 1CD rotation in Iraq.
- CPOF was not in the Army Program Objective Memorandum for funding, nor was there an office established that would be able to take on a new program with many technical challenges still ahead.
- No approved requirement document was in place calling for a stand-alone system like CPOF.
- CPOF needed to meet the requirements imposed by the acquisition regulations and laws.
- Significant risks—namely scalability, performance, and ABCS interoperability—still needed to be reduced to enable a broader use of CPOF.
- CPOF had minimal capability to interoperate with other Army and Joint systems.

To tackle these hurdles and maintain the momentum of the CPOF program, the PEO C3T and DARPA joined forces.

The Army Acquisition Executive (AAE) assigned CPOF management authority to PEO C3T, and directed that the designated program management office enter into an agreement with DARPA to support the transition of CPOF technology to the Army. PEO C3T gave responsibility for CPOF to PM Battle Command. In October 2004, the Army opened a small program office for CPOF.

The 2 years' leadership overlap, from 2004 to 2006, between DARPA and the Army allowed time for relationships to develop, for technology transfer to occur, and for the acquisition steps necessary for an Army POR to be developed and approved. The Army PM shop integrated CPOF requirements into the Maneuver Control System (MCS) Capabilities Production Document (CPD), wrote a Test and Evaluation Master Plan (TEMP), and obtained the necessary Army and Joint approvals necessary to field and sustain a POR.

Formal transition of CPOF to the Army occurred in April 2006, and is documented in PEO C3T's CPOF Decision Point 1 (DP1) Acquisition Decision Memorandum (ADM).

Ongoing Development

MODELING AND SIMULATION

CPOF developers relied on modeling and simulation as well as heavy experimentation to quickly grow CPOF into a successful theater-wide system. CPOF had three major technical challenges to overcome in the near term: scalability, system stability, and ABCS interoperability. To meet these challenges, new technologies and data management strategies were modeled for their impact on the architecture. For example, a mid-tier server concept was introduced to ease the bandwidth utilization over tactical networks. Through modeling and experimentation, CPOF was able to demonstrate significant bandwidth reduction.

The first step in any effort to develop software is to get consensus from the user community, including the direct users, on a concise set of requirements. Often this can be difficult, but since CPOF was fielded to select users as a commander's tool in 2004, direct user feedback was readily available. The user and Field Support Representative (FSR) feedback was the primary source used to define and refine the requirements. Each time a new capability was added, it was evaluated and feedback was again given by the end-users and the FSRs. This constant feedback loop provided gradually increased capability by allowing the software developers to focus directly on the issues identified by the users. It produced a higher quality, more useful end product in a very short period of time.

The use of experimentation reduces program risk by continually testing out new functionality and incorporating real-world feedback. Resources are not applied against a capability—either hardware or software—until the users and support people concur that it is worth the cost and additional risk.

SPIRAL DEVELOPMENT

The employment of end-user and FSR feedback in an "experimentation" mode allowed a tighter or faster spiral development process to occur (vice the traditional software waterfall development). Following is a description of the key capabilities of the first two major spirals in the CPOF development, each about a year apart.

CPOF version 2.4 was the version resulting from the spiral development that was occurring in-theater. Some characteristics of this version are:

- Operates with latency of up to 1400 ms
- Bandwidth use up to 18–28 Mbps during peak usage to support a division fielding

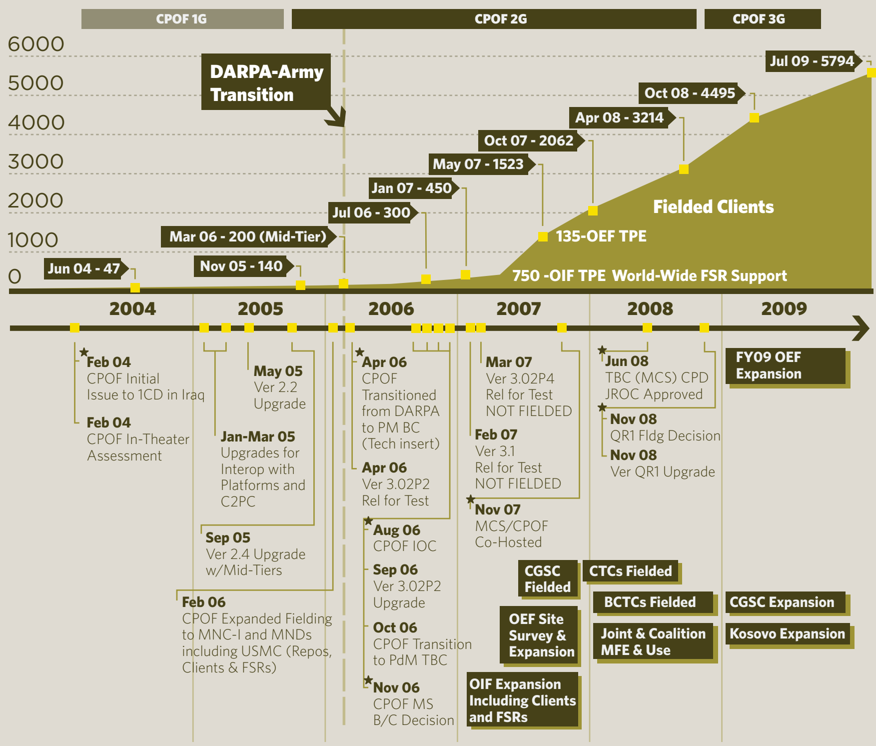
- Scaled to 200–250 users on a single master repository, with 40 users at the mid-tier
- Supports 7 ABCS threads and 41 common tactical graphics.

The next version, CPOF 3.0 that 4th Infantry Division used, improved all of these characteristics:

- Operates with latency of up to 2,100 ms
- Bandwidth use up to 5–6.5 Mbps during peak usage to support a division fielding
- Scaled to 300+ users on a single master repository, with 60 users at the mid-tier
- Supports 14 ABCS threads and 89+36 common tactical graphics
- Increases stability via almost 300 CPOF bug fixes.

Figure 3 shows the CPOF maturation and development through present day that continues to address warfighter issues.

FIGURE 3. CPOF MATURATION OVER TIME



At this point CPOF had met the Army criteria for transition from DARPA to the Army in the April 2004 MOA. In parallel with the DARPA-sponsored spiral development work in-theater, the Army program office developed an acquisition strategy to transition the program into a POR.

DEVELOPMENT OF THE BATTLE COMMAND VISION FOR THE FUTURE

The Battle Command Migration Plan was developed and refined to map out the development, fielding, and finally, retirement path for ABCS for the near- and long-term future. It was developed in the context of the current Army environment—the Army at war in Operation Iraqi Freedom/ Operation Enduring Freedom (OIF/OEF), the need for increased Joint interoperability, and Future Combat Systems/Net-Enabled Command Capability (FCS/NECC) schedules. The plan took into account the need for technology insertions due to the rapidly changing available commercial products, and the need to upgrade existing software to better use the technologies that are available. The goals of the Battle Command Migration Plan included lowering life cycle cost by moving to a smaller footprint; making the systems easier to use, train, and configure; and fielding a single standard capacity to every unit that provides the basis for their unique tailoring needs.

CPOF was one of the first technology insertions into the existing ABCS 6.4 System of Systems. The Battle Command vision is to leverage the CPOF technology, including its collaboration services and graphical user interface, as a front end for all Battle Command applications/users and possible transformation into the single visualization system for Battle Command. Key development tasks are planned to enable this, including:

- Defining an open set of Application Program Interfaces (APIs) and a Third Party Development Kit (3PDK) to enable multiple vendors to build CPOF-enabled modules for specialized Battle Command functionality
- Leveraging DoD standard mapping services, such as the Commercial/Joint Mapping Tool Kit (C/JMTK), to provide a richer set of mapping capabilities, including common symbology and maps
- Leveraging common Active Directory services for common user management and authentication across CPOF and the Battle Command infrastructure
- Leveraging a future PEO-provided Tactical Enterprise Voice Over Internet Protocol (VOIP) solution; Warfighter Information Network-Tactical (WIN-T) is the targeted POR to provide this capability.

One of the key ideas in this vision is leveraging the capability in CPOF to which the soldiers in the field consistently give high marks—ease of use and ease of training. This common platform provides a consistent map and set of graphics, greatly enhancing interoperability.

Reducing Risk

All of the above—the experimentation in-theater, spiral development, and development of the vision for the future—was done in parallel. The goal of all of this was to get the fullest capability to the soldier rapidly, while laying the groundwork for future development—all while reducing program risk.

RISK MANAGEMENT

Risk management was one of the major project management tools for CPOF development, test, and fielding. The CPOF effort is continuously evaluated to determine exposure to risk and how to best handle such exposure. Specifically, the risk management aspect of the CPOF aims to allow CPOF to be fielded to the user community with as many risks identified, mitigated, or categorized as acceptable, as possible (Thomas & Cook, 2005).

The Product Manager, Tactical Battle Command (responsible for CPOF), and the contracted development team are both responsible for performing risk management activities. The contractor is responsible for assigning appropriate parties and/or organizations for enforcing and performing risk management activities.

An example of a risk matrix is shown in Figure 4. It identifies risks, categorizes them, and suggests possible mitigation. One of the things that makes this management tool so effective is that the risks and possible mitigation paths are publicly discussed. In this way, the entire community comes to a similar understanding of the capabilities and limitations of the product. The acquisition strategy was directly tied to the risk analysis. The events and decisions were based on the identified risks. Major risk areas identified were:

- Scalability
- Interoperability
- Supportability
- Full-Spectrum Operations
- Architecture

Development efforts were designed to address these major risk areas.

FIGURE 4. RISK MATRIX

Category	Risk (RIN)	Mitigation (Handling)	Metric (Monitoring)	Risk Status	Risk Assessment
Supportability (Low/Moderate)	FSR Support • Ability to support full Army fielding IAW PM Support concept (multifunctional FSRs) • Stovepipe support structure • Incorporation of FSR Experience into Design Process • Downsizing of FSR Personnel	Simplify/Stabilize SW Automate maintenance function Cross-functional FSRs across BC Dev existing BC support base for CPOF Integrate into the Army Support Structure	FSR/Unit (DIV/BDE/BN, etc) Data Integration for Reporting and Reuse	The System of System (SoS) Migration Plan Implementation and the mandated FSR reduction requirement for FY08 drives this risk.	
	Software Supportability/Efficiency • Ability for CPOF software to aid in and provide a Stable CPOF Network • Ability for CPOF to be upgraded and fixed as needed, on the fly and from a remote location. • SW Documentation • CM Processes • Garbage Collection • 64 Bit Backup Processes	Deploying 'SuperTech' developer to theater Implementation of Development Crisis Team Develop remote admin and distribution capabilities	Computer Resource Utilization/Available SW Quality Level Used Standards Metric Reliability (Fault Tolerance, recoverability) Maintainability (Stability, changeability) Operational Ability (Ao)	Current development tasks are designed to increase the ability of the baseline 3.0.2 Software to aid in the supportability area. Development remains on track but the technical difficulty of implementation drives this risk to be moderate.	
	Hardware Support & Acquisition Processes • Hardware Availability and Lead Time to support on-going ops • End of Life • Maintain multiple configurations	Buffer Supply of hardware to deploy as needed Leave behind hardware in Theater for next units to fall in on Use Spares to fill in gaps until hardware arrives UID CM Process, Documentation and Enforcement	Estimated vs. Actual Delivery Times Maintenance Downtime Repair Cycle Time Parts Availability	Contact is in place for the acquisition of hardware and support. The implementation of a Configuration Management process will be in place by FY07 thus helping reduce the risk.	
	Training • Training structures integrated into mainstream Battle Command Support Structures	Inclusion of an embedded trainer. Training and Support package for NET, TRADOC and Sustainment	Actual vs. Planned # of personnel attending Training Systems Available Student Proficiency /Skill Level Training Level vs. Proficiency	Logistics Products are currently being developed to improve current training and to meet the First Unit Equipped Date (FUED).	
Technical (Moderate)	• Incompatible Versions of Fielded Software • Bug Fixes and Patch Upgrades • Inadequate Evaluation of SW	Implementation of Multiple CPOF Networks PASS to Exchange Information Field New Units CONUS Evaluate and Determine Criticality of Bug Fixes and Patches. If possible Roll Up to decrease system upgrade times. Remote Admin push of small critical updates	# and Version Type of CPOF Networks # of Total SW Bugs vs. # Critical SW Bugs Percentage of Total Critical Bugs Fixed	Currently, Bugs are identified, evaluated and rolled up into fixes and patches based on prime 's processes. New implementation calls for GOV approval and structuring of Patches, Fixes and Smaller Releases to allow for identification of critical elements and establishment of acceptable timeframes.	
	Current Software Limitations • No Full spectrum Ops • No Ruggedization • Limited Interoperability • Theater Requested Enhancements • Marine Requested Enhancements	Expectation Management Customer Awareness Evaluate and Implement Important Theater/Marine Requests using out Quick Reaction Theater Development Support and Prime SW Development Team	# Theater/Marine Requests Outstanding Average Implementation Time of Theater/Marine Requests	Currently CPOF Block 2 Requirements do not provide complete Full Spectrum Capability to the Warfighter. Currently effective customer management by PO and FSR Personnel help to give Customers an understanding of when capability will become available. Most new requirements are processed and approved by the TSM.	

FIGURE 4. RISK MATRIX

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	Software Supportability/Efficiency • Ability for CPOF software to aid in and provide a Stable CPOF Network • Ability for CPOF to be upgraded and fixed as needed, on the fly and from a remote location • SW Documentation • CM Processes • Garbage Collection • 64 Bit Backup Processes	Deploying 'SuperTech' developer to theater Implementation of Development Cross Team Develop remote admin and distribution capabilities	Computer Resource Utilization/Available SW Quality Level Used Standards Metric Reliability (Fault Tolerance, recoverability) Maintainability (Stability, changeability) Operational Ability (Ao)	Current development tasks are designed to increase the ability of the baseline 3.0.2 Software to aid in the supportability area. Development remains on track but the technical difficulty of implementation drives this risk to be moderate	
	Hardware Support & Acquisition Processes • Hardware Availability and Lead Time to support on-going ops • End of Life • Maintain multiple configurations	Buffer Supply of hardware to deploy as needed Leave behind hardware in Theater for next units to fall in on Use Spares to fill in gaps until hardware arrives UID CM Process, Documentation and Enforcement	Estimated Vs. Actual Delivery Times Maintenance Downtime Repair Cycle Time Parts Availability	Contact is in place for the acquisition of hardware and support. The implementation of a Configuration Management process will be in place by FY07 thus helping reduce the risk.	
	Training • Training structures integrated into mainstream Battle Command Support Structures	Inclusion of an embedded trainer. Training and Support package for NET, TRADOC and Sustainment	Actual vs. Planned # of personnel attending Training Systems Available Student Proficiency /Skill Level Training Level vs. Proficiency	Logistics Products are currently being developed to improve current training and to meet the First Unit Equipped Date (FUED)	
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Specific tasks to address these risks have been developed and crosswalked with the TRADOC Capabilities Manager (TCM)-developed requirement. Then these requirements are balanced with the expected resource availability to develop the build plan.

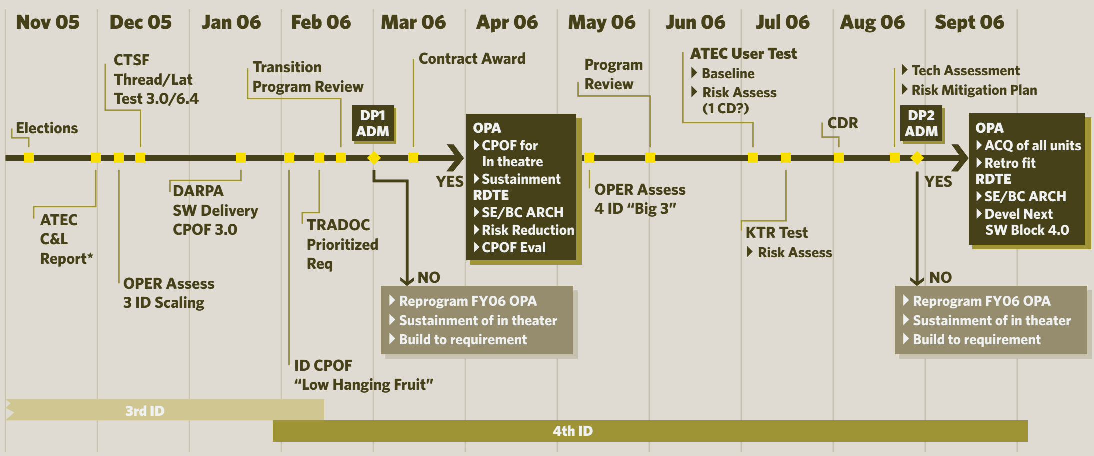
Risk assessments were done in parallel with the early DARPA development. It was clear that CPOF, while providing needed capability in-theater, needed work to become "productized." Risks to the program—technical and programmatic—were identified. Then mitigation plans were developed openly for each risk. This in-theater feedback loop—shortfalls identified, fed back into the risk plan, mitigated, and fixes sent back in-theater—allowed incrementally better product to get into the soldiers' hands quickly.

TAILORING ACQUISITION STRATEGY TO ACCEPT THE NEW TECHNOLOGY USING A SPIRAL PROCESS

The standard DoD 5000 acquisition strategy was tailored specifically to allow the new CPOF technology to make it to the field sooner rather than later. It was also tailored so that CPOF could be incorporated as a technology insertion into the ABCS System of Systems.

The acquisition strategy was specifically designed around mitigating risks. An honest risk assessment was the first step—do the analysis of CPOF's shortfalls and put mitigation plans in place for each identified risk. The development tasks fell out of the mitigation plans. For example, one risk was scalability in-theater; i.e., moving from 200 users to more than 1,000 users. The mitigation plan noted that the server architecture

FIGURE 5. ACQUISITION DECISION FLOW CHART



**Based on 4th Infantry Division Mission Rehearsal Exercise (MRX) (29 Jul-4 Aug), 1st Brigade Combat Team National Training Center Rotation (6 Sep-4 Oct) (and the 3rd Infantry Division Full Operational Assessment III in-theater—Tentative)*

would not support that many clients (users). The redesign of the server architecture to add mid-tier servers was a key development task. The strategy was developed to fix the risks over time, rather than trying to develop the perfect product in one delivery.

The Acquisition Decision Flow Chart is shown in Figure 5. It shows two decision points (DP) where leadership had the opportunity to review the progress of the program and to decide if the program was ready to move forward as planned. Each of these decision points was linked to an event that could be used to demonstrate whether or not CPOF was ready to move ahead. These decision points enabled the leadership to evaluate program risk to determine the best path forward.

The acquisition strategy included two key decision points as shown in Figure 5. These were selected in advance at junctures in the program where go/no go-type decisions could be made. These decision points were not selected based on schedules, but rather on whether the program was capable of proceeding to the next step in the acquisition process, i.e., they demonstrated readiness for transfer and reduction of risk. Decision Point 1 (DP1) was held to determine if CPOF had met the transition goals for the Army to accept the technology from DARPA. DP2 was a Milestone C-like event to determine if CPOF was capable of being fielded as part of the software block to the entire Army. For Decision Point 2 (DP2), a brief was given to the community, including the General Officer (GO) leadership, showing that CPOF had the capability, certifications, documentation, and sustainment capability to support the decision for fielding.

The CPOF Addendum to the MCS Acquisition Strategy was signed by MG Michael R. Mazzucchi, USA (Ret.), in July 2005.

- CPOF is a technology insertion into MCS, which was in full rate production.
- To ensure that DARPA met the conditions of the Army-DARPA MOA and that CPOF was performing satisfactorily in unit operations, the Army conducted a Level I Development Test (DT) event and a series of Level II Operational Assessments of CPOF in fielded units. These assessments provided data for informed decisions at DP1 and DP2, respectively.
- DP1 was conducted in March 2006, and documented in the PEO C3T DP1 ADM dated April 2006. The purpose of this decision point was to accept transition from DARPA and approve Research, Development, Test, & Evaluation (RDT&E) funding to reduce risk and baseline/assess the CPOF system; and to approve Other Procurement, Army (OPA) funding to support theater and continental United States fielded units. DP2 included a CPOF Block II Milestone C to determine whether the current block of software/

hardware was suitable for fielding in accordance with the ABCS 6.4 schedule. DP2 also included CPOF Block III Milestone B to authorize research, development, and test activities for continued CPOF development.

- The CPOF acquisition strategy reflected the use of innovative solutions and utilized best practices in the following aspects:
  - Extensive use of integrated government-developed software and COTS software
  - Streamlined acquisition processes wherever appropriate
- Capability is to be provided incrementally, putting the best of 80 percent solution into the field quickly.
- Contracting Strategy
  - Software—Software development, software maintenance, fielding support, field service support, training, and documentation were procured via a 5-year sole source (i.e., a 1-year basic plus four 1-year options) basic ordering agreement with the software developer. Upon attaining a successful DP2, task orders were awarded on an annual basis as required to support additional fielding of the baseline CPOF product and related activities.
  - Hardware—Hardware and peripherals to support CPOF fieldings were procured via award of task orders on a competitively awarded hardware ordering contract. Hardware procurement included a 5-year warranty for all items.

Design and Program Reviews were also scheduled at regular intervals. These gave the leadership and the rest of the community an opportunity to evaluate CPOF. This helped ensure that CPOF development stayed in sync with the rest of the Army programs, and that the program risk was within acceptable limits. The acquisition plan also specified design reviews. These reviews were publicly held and covered technical, programmatic, and funding issues. They were intended to engage the community. Again, the philosophy is that the more that is known about a system's capabilities and limitations, the better the focus that can be brought to solve issues. This allows a more capable, useful system to make it to the field.

Lessons Learned: Best Practices for a Successful Transition

Inserting a new technology into an existing System of Systems is not a straightforward or easy task, but some key lessons were learned during the CPOF transition.

LEADERSHIP

Leadership of both the technology provider and the receiver must be fully engaged and supportive. The MOA helped ease the transition by providing a 2-year window, along with adequate funding, for the DARPA and Army teams to collaborate on how best to grow CPOF into a fielded system used by soldiers every day.

VISION

A vision, both near-term and long-term, greatly helps in both acquisition and technical issues. The vision to use CPOF as the common platform for collaborative services has stretched the original system to fill gaps left by the other ABCS system of systems. The vision provides the framework for breaking large strategic goals into smaller, more executable ones. It also helps prioritize efforts.

EXPERIMENTATION

Experimentation is needed in developing a successful product. Exposing ideas to actual (vs. laboratory) conditions changes the way designers and developers view the system. Many improvements to CPOF were made because the system was deployed in-theater so early in its development cycle. Even after CPOF was integrated into the ABCS system of systems and had scaled to over 5,000 systems, experimentation continues. A concerted effort is underway to continually solicit and incorporate all user feedback into the system to make it relevant to the current fight. Experimentation must involve the user up front and early with a tight feedback loop with the developer.

EVENT-DRIVEN PROCESS

The spiral process used to insert CPOF into the ABCS POR was a tailored DoD 5000 process. It was event-driven, using regular, scheduled decision points to proceed. At each, the system was honestly evaluated to determine progress and to steer towards the optimal path forward.

MANAGING CHANGE

Any new system or technology will require changes or adjustments once exposed to real-world conditions. CPOF, in the years that it has been in the field, has changed significantly. It has been scaled up from just a handful of systems and now interfaces directly into ABCS. CPOF is an official part of the LandWarNet (LWN)/G3 software baselines that are fielded to Army. This has only been possible because all parties have embraced the new technology and worked hard to incorporate it and tailor it to best advantage. Accepting and managing the change have made this possible!

COMMUNITY RISKS

Most importantly, communicating risks and issues in an open, honest way helped manage expectations of soldiers, leadership, and technologists. Regular risk assessment and mitigation discussions at all levels helped focus resources where they were needed most. For example, one early technical risk was the concern about how the CPOF network would scale in-theater. The mitigation for this risk, which was actually executed, was to incrementally grow the network in-theater. This was successful and allowed the users and technical support to address smaller issues as they occurred.

Conclusions

The transition of CPOF from DARPA to the U.S. Army was successful for a number of reasons. Tailoring the DoD 5000 acquisition strategy allowed new CPOF technology to be fielded as a technology insertion into the ABCS. The keys to this successful transition can be linked to the efficient use of risk management techniques to drive the program forward, use of early and sustained feedback from the user community, maintaining transition funding stability, and honest and open communication between all stakeholders.

ACKNOWLEDGMENTS

The authors would like to thank LTC Richard Hornstein, USA, Product Manager, Tactical Battle Command, and his team for answering many questions and helping ensure the accuracy of the information. They would also like to thank Ms. Sheri Silverstein for assisting with the research.

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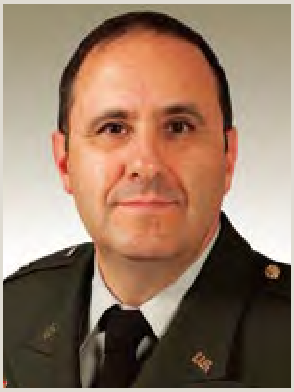

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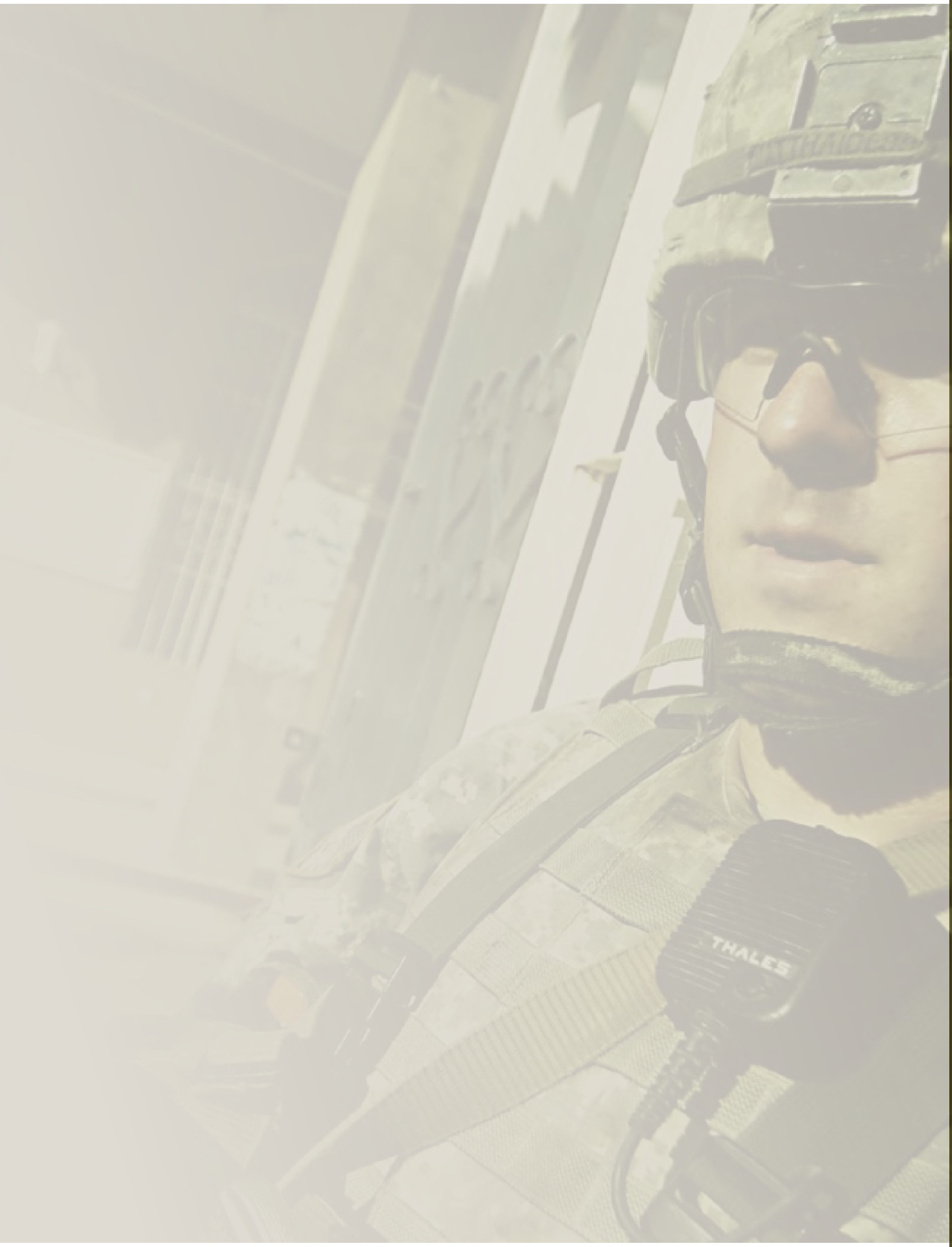
APPENDIX

List of Abbreviations and Acronyms

1CD	First Cavalry Division
3PDK	Third Party Development Kit
4ID	Fourth Infantry Division
AAE	Army Acquisition Executive
ABCS	Army Battle Command Systems
ACQ	Acquisition
ADM	Acquisition Decision Memorandum
API	Application Program Interface
BC	Battle Command
BCTC	Battle Command Training Center
BDE	Brigade
BN	Battalion
C2PC	Command and Control Personal Computer
C&L	Capabilities and Limitations
CDR	Commander
CHS	Common Hardware Systems
CGSC	Command and General Staff College
C/JMTK	Commercial/Joint Mapping Tool Kit
CM	Configuration Management
COTS	Commercial Off-the-Shelf
CPD	Capabilities Production Document
CPOF	Command Post of the Future
CTSF	Central Technical Support Facility
DARPA	Defense Advanced Research Projects Agency
DDR&E	Director, Defense Research and Engineering
Devel	Develop
DIV	Division
DoD	Department of Defense
DP	Decision Point
FCS	Future Combat Systems
Fldg	Fielding
FOC	Financial Operational Capability
FSR	Field Support Representative
GO	General Officer
Interop	Interoperability
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
JROC	Joint Requirements Oversight Council
KTR	Contractor
Lat	Lateral

LRIP	Low Rate Initial Production
LUT	Limited User Test
LWN	LandWarNet
MCS	Maneuver Control System
MFE	Material Fielding Exception
MNC-I	Multi National Corps Iraq
MND	Multi National Division
MNS	Mission Needs Statement
MOA	Memorandum of Agreement
MS	Milestone
NECC	Net-Enabled Command Capability
NET	Network
NOSC	Naval Ocean Systems Center (Navy Laboratory)
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OPA	Other Procurement, Army
OPER	Operational
ORD	Operational Requirements Document
PASS	Publish and Subscribe System
PdM TBC	Product Manager, Tactical Battle Command
PEO C3T	Program Executive Officer, Command, Control, and Communications—Tactical
PO	Program Office
POR	Program of Record
QR1	Quarterly Release 1
RDT&E	Research, Development, Test, and Evaluation
Rel	Released
Repos	Repository
RIN	Risk Identification
S&T	Science and Technology
SE/BC ARCH	Systems Engineering/Battle Command Architecture
SoS	System of Systems
SW	Software
TBC (MCS) CPD	Tactical Battle Command (Maneuver Control System) Capabilities Production Document
TEMP	Test and Evaluation Master Plan
TRADOC	Training and Doctrine Command
UID	Unique Identifier
TRL	Technology Readiness Level
TSM	TRADOC Systems Manager
USMC	United States Marine Corps
Ver	Version


THALES

LEAD SYSTEMS INTEGRATORS: A POST-ACQUISITION REFORM RETROSPECTIVE

Kathlyn Hopkins Loudin

This article explores concerns about the mid-1990s Acquisition Reform notion of partnering with industry. Design Agent, Lead Systems Integrator, and Total System Performance Responsibility roles were conveyed to companies charged with system design, technology development, and funds allocation, while balancing cost, schedule, and performance goals for program success. Although these arrangements arose from noble intentions, recent critics have posited that they have driven cost growth and have weakened DoD's ability to coordinate and control acquisition programs. The author infused real-world phenomena with elements of economic transaction cost theory and network theory to make recommendations about future optimization of roles.

Keywords: *Acquisition Reform, Cost Growth, Industry, Design Agent, Lead Systems Integrator (LSI), Total System Performance Responsibility (TSPR)*

image designed by Miracle Riese »


Funding Allocation
Acquisition Reform
design
agent
balancing
cost
technology
development
system design
INDUSTRY
EMS INTEGRATORS
cost
growth
Funding
Allocations
technology development
Schedule
system
design
Performance
Goals
LEAD SYSTEMS
INTEGRATOR
ystem
mance
design agent

Multibillion-dollar acquisition challenges, such as those confronted by the Navy's Littoral Combat Ship program and the Army's Future Combat System, have sharpened public focus on the Department of Defense (DoD)'s ability to manage programs and control costs. This has triggered concerns about initiatives brought into vogue more than 10 years ago, prompted by mid-1990s Acquisition Reform-type thinking about fresh environments in which efficiency and effectiveness can flourish.

One such notion from that era embraced the philosophy of "partnering with industry." Titles such as Design Agent, Lead Systems Integrator, and Total System Performance Responsibility were bestowed upon private companies entrusted with broader, more influential roles than ever before. These involved system design, technology development, acquisition, and funds allocation—all the while balancing cost, schedule, and performance goals to ensure program success.

Acquisition Reform in Retrospect

Acquisition is among the most "reviled, reviewed, and reformed" activities of government (Besselman, Arora, & Larkey, 2000, p. 423). With more than $314 billion at stake annually (GAO, 2008), DoD programs understandably attract scrutiny. Ideological changes come with new Presidential administrations and prompt policy swings, often from one extreme to another. Under the Obama Administration, the recently signed Weapon Systems Acquisition Report Act of 2009 aims to bolster DoD's workforce, increasing systems engineering and program oversight.

In contrast, the mid-1990s vision of Acquisition Reform aimed at achieving efficiencies. Diminishing post-Cold War budget realities led to the Federal Acquisition Streamlining Act of 1994; this was advanced by subsequent legislation. DoD implemented the Clinger-Cohen Act of 1996, the Federal Acquisition Reform Act of 1995, and the Government Results and Performance Act of 1993 in accordance with Office of Management and Budget (OMB) Circulars A-130 and A-11. One key assumption of these reforms was that cost efficiency could be improved by using contractors more effectively—sometimes in more powerful roles than ever before.

Background

Within the military services, different terms are used to describe this business arrangement. "Lead Systems Integrator" (LSI) appears across the Services, but is most heavily used by the Army. The LSI concept was first manifested in a 1997 contract with Boeing for National Missile Defense, a complex system of systems. Boeing's scope transcended that of a typical prime contractor. It involved concept definition, overall

systems engineering and integration, and leadership of Integrated Product Teams (IPTs). According to Gholz (2004), subsequent LSI contracts were awarded to Boeing for essentially masterminding equipment vital to future operational capability. Similarly great expectations were conveyed to the Boeing-Science Applications International Corporation (SAIC) team on Future Combat Systems (FCS).

Within the Navy, "Design Agent" connotes responsibility for systems design and development. This entails generating requirements, developing technology, leading systems integration, allocating resources on behalf of the customer, managing supply chains, and conducting testing and validation—sometimes all the way through Low Rate Initial Production (LRIP). The Navy sometimes uses "Design Agent" and "LSI" interchangeably.

Within the Air Force, "Total System Performance Responsibility" (TSPR) emerged in contract clauses in the 1970s. In 1999, the Air Force chartered a TSPR working group, whose recommendations led to certain contractors taking responsibility for design, configuration, and requirements solutions, as well as accountability for fielded systems. White (2001) characterizes TSPR as encompassing: (1) integration of the aircraft, its subsystems, and all components (hardware, software, data), whether provided as Government Furnished Property (GFP) or acquired commercially, and (2) assurance that the system will meet specifications. Example programs include the F-117 and the Space-Based Infrared System High.

Irrespective of nomenclature differences, by the late 1990s, the Services had begun to shift more development and systems engineering work to the private sector. Under traditional acquisition strategies, DoD procured various weapons, components, and platforms, and then combined and refined them, eventually achieving operational capability. Influenced heavily by the post-Cold War "peace dividend" aimed at reducing spending on procurements, facilities, and people, however, new strategies called for DoD's issuance of a Statement of Objectives (SOO). Then qualified industry partners could derive technical specifications and determine how to allocate Research and Development (R&D) and procurement funds. This was predicated on the notion that industry possessed the broad technical and programmatic knowledge needed to meet cost, schedule, and performance objectives—and was strongly motivated to do just that.

Although this model was favored for its consistency with business transformation efforts, it drew criticism. For instance, the Defense Science Board (2002) assessed systemic causes of cost overruns, schedule slippages, and capability shortfalls, and pointed to a "hollowing out" of organic systems engineering capability within DoD. Others voiced concerns over the increasingly blurred lines between government and industry.

Blurring the Lines: Partners and Primes

When contractors are enlisted to work in ways that depart from tradition, organizational roles require redefinition. Rainey (2003) extended the typology by categorizing different economic sectors not merely as public or private, but as mixed, intermediate, or hybrid, noting that many private, for-profit companies work with government in ways that transcend normal boundaries. For example, early news releases for the FCS team touted Boeing and SAIC not as contractors, but as full-fledged government partners.

While the idea of productive public-private partnerships is appealing, lines of demarcation between "inherently governmental" and "commercial" activities need to be thoroughly understood. Circular A-76, published by the Office of Management and Budget (OMB, 2003), states:

> An inherently governmental activity involves: (1) Binding the United States to take or not to take some action by contract, policy, regulation, authorization, order, or otherwise; (2) Determining, protecting, and advancing economic, political, territorial, property, or other interests by military or diplomatic action, civil or criminal judicial proceedings, contract management, or otherwise; (3) Significantly affecting the life, liberty, or property of private persons; or (4) Exerting ultimate control over the acquisition, use, or disposition of United States property, [including] collection, control, or disbursement of appropriated and other federal funds. (p. A-2)

OMB Circular A-76 does permit private firms to engage in activities involving discretion, provided that the firm holds no decision-making authority, but instead develops options and implements actions under government supervision. Similarly, under the 2008 National Defense Authorization Act (NDAA), DoD may contract for acquisition support on major systems development and production, provided that the contractor performs no inherently governmental functions and makes no decisions on technical performance. The 2009 NDAA calls for policy standardization on inherently governmental functions and potential conflicts of interest.

Therein lies the challenge, of course: Consistent policy implementation is difficult under the best of conditions. It is daunting in highly complex, high-dollar acquisitions involving systems of systems. Numerous analysts have sounded alarms over the "hollow state," or its inability to convey sound technical direction to contractors (Crawford & Krahn, 1998; Kettl, 1988; Milward, 1996). This often culminates in cost overruns, performance problems, and recurring ambiguity regarding responsibilities.

Concern over casting contractors in non-traditional, influential roles had escalated by 2007. Then-Secretary of the Navy Donald Winter voiced

discontent with current business practices, stressing the erosion of engineering expertise within the Navy and over reliance upon contractors. He also criticized the Pentagon for its failure to understand competitive pressures and Wall Street expectations. Winter's speech, delivered while the Navy was renegotiating its Littoral Combat Ship contract with Lockheed Martin, stressed that the LSI should be a DoD entity, not a contractor (Castelli, 2007).

The 2008 NDAA contained language barring the award of new LSI contracts after FY 2010; with few exceptions, it prohibited such arrangements for programs beyond LRIP. The NDAA for 2009 specifically forbids the award of an LSI contract for LRIP or full-rate production of major elements of the FCS program. Given these stipulations, it is clear that partnerships with industry, once believed to boost efficiency and effectiveness, are now destined for the history books.

Review of the Literature

The author found few quantitative analyses of Design Agent, LSI, or TSPR arrangements; most were qualitative in nature. White (2001), for example, assessed the value of TSPR in Air Force acquisition strategies using multiple case studies and self-reported data. White reported that one program office realized $1.2 billion in cost savings over a 10-year period; they cited manpower reductions, competition, and contractor innovations, but provided no substantiation. Still, White concluded that TSPR arrangements could produce cost savings, but stated that TSPR impact on program performance remained unclear.

Flood and Richard (2005) authored a qualitative study of the LSI experience of the Army FCS program. They compared the LSI model to DoD's traditional program office model, weighed the pros and the cons of each arrangement, and suggested strengthening processes, clearly defining program objectives, and instituting a success-oriented culture. Similarly, Gholz (2004) presented a qualitative assessment of LSI arrangements, cautioning governments against over-centralization of acquisition activities. Gholz also warned against possible abdication of leadership responsibility and the atrophying of the government's technical competency.

Considering alternative DoD acquisition arrangements more broadly, other studies have endeavored to augment qualitative data with numbers. In an examination of Defense Acquisition Pilot Programs (DAPPs), Reig (2000) baselined the initial state, identified changes, and measured their impact. Reig combined cost and schedule metrics from Selected Acquisition Reports (SARs) with performance data from test reports of Acquisition Category (ACAT) I programs prior to Acquisition Reform. He

contended that DAPPs could not be meaningfully compared to "standard" programs unless they were developed contemporaneously.

Literature on the general contracting-out debate was abundant; some of it delved into the quantitative. Globerman & Vining (1996) attempted to calculate the cost of contracting out. The Government Accountability Office (GAO) has conducted numerous cost comparisons, but reported in 2008 that data are generally inconclusive. GAO (2007) reported that, although DoD maintains data from competitive sourcing (i.e., A-76) efforts, the number of competitions is small, and results may not be generalizable. Other studies include Smith & Smyth (1996), who addressed accountability in contracting, and Miles and Snow (1992), who identified drawbacks to contracting out. Goodsell (2007) referred to the Constitution's preamble for determining what is inherently governmental. Kelman (2007), formerly head of Office of Federal Procurement Policy, published a treatise on astute contract management to combat cost overruns and performance failures.

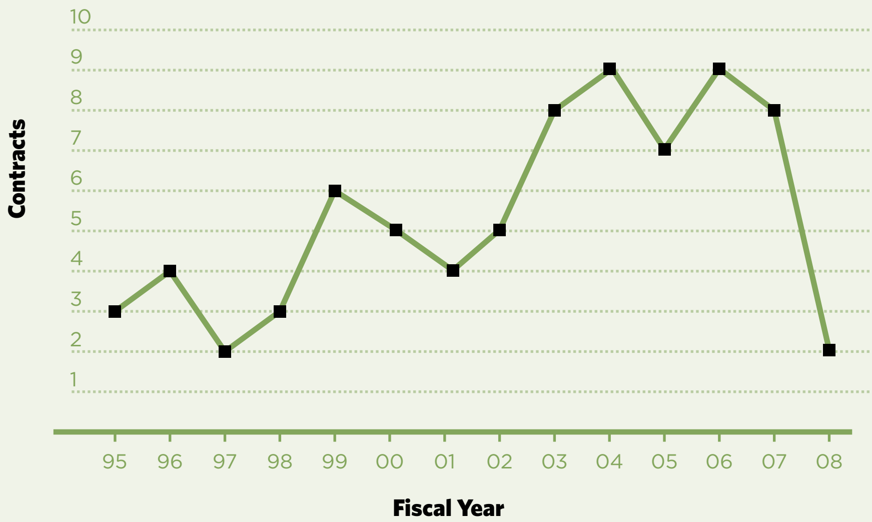
Finally, literature on the "demanding customer" and the implications of "hollow" organizations (Crawford & Krahn, 1998) tied empirical data to theory. Frederickson and Frederickson (2000) contributed to network theory by articulating an array of engagements among entities, including formal contracts, grants, regulations, and other transactions; their work was qualitative in nature. The preponderance of qualitative work is not surprising, given problems with gathering, normalizing, and interpreting quantitative data, particularly public-domain data.

METHODOLOGY 1: QUANTITATIVE ANALYSIS

To gauge the prevalence and dollar value of LSI-like contracts, the author conducted a keyword search within DoD's public archives (DoD, 2009b) to find all contracting actions valued at more than $5 million between October 1994 through March 2008. Keywords used were "Design Agent" or "Lead System(s) Integrator" or "Lead System(s) Integration." Dozens of contracting actions were found: Their values ranged from $5 million to $2.879 billion.

The figure shown here reflects trends that can be detected from the data. First, soon after Acquisition Reform, the number of LSI-like contracting actions ascended, reflecting an initial burst of activity consistent with new policies. With the turn of the century came a leveling off; this could indicate a time of policy analysis and program evaluation. Then during 2002—2004, the number of actions reached a new peak. Their dollar values increased, as well. The Navy contracted for billions of dollars of support to then-DD(X) and nuclear submarine programs. After 2004, the purity of LSI-like contracts became increasingly suspect, as hybrid contracts for design and maintenance emerged. By 2007, the popularity of LSI-like efforts declined; this is consistent with DoD's changing stance

FIGURE. PREVALENCE OF LSI-TYPE CONTRACTS OVER TIME, 1994-2008



on acquisition strategies. (The 2008 legislation on phasing out contractor-as-LSI arrangements was preceded by several years of intense scrutiny by the GAO, the Congressional Research Service, and others.)

The author acknowledges limitations to the data. First, nomenclature used in contract announcements was inconsistent. Several news items indicated that "Design Agents" were being used for maintenance on an aging class of ships. Other contracts that were clearly LSI in nature lacked those keywords. Therefore, some work is counted too heavily and some is not counted at all: It is difficult to gauge the extent to which these factors offset one another. Secondly, attempts to assign values to actions were complicated by the fact that only Contract Line Item Number (CLIN) ceiling amounts were reported. In cost-plus contracting, CLIN ceilings may or may not have been fully funded. Valuation of LSI-type scope as a subset of the overall contract value was problematical as well, given limited public information.

Still, having traced the general build-up and demise of non-traditional arrangements, the author attempted to compare the acquisition costs and performance effectiveness of contractor-led acquisition programs to those of government-led acquisition programs of similar scope. This was complicated by issues identified by Reig (2000): Contractor-led programs came into vogue during a period of time when few comparable government-led programs were at the same stage of development. Organizational culture and interorganizational relationships—both time-sensitive—can also influence cost savings and performance. Thus, it is unfair to pit a pre-1990s government-led effort against a post-1990s

contractor-led effort. Moreover, other aspects of post-Acquisition Reform culture converged during this timeframe. The government adopted more commercial-like practices, and other innovations such as Prime Vendor Support strategies were tested.

For these reasons and others, it is difficult to isolate the LSI variable and gauge its impact on cost and performance. Other issues include: (a) lack of commonality in contractor cost estimating and contractor cost reporting requirements, (b) lack of completeness in cost and pricing data, (c) the dynamic nature of government cost estimates, and (d) limitations inherent to public-domain data.

In complex system-of-systems efforts involving numerous entities, cost and performance data are clouded by commonality issues. First, firms differ in their accounting systems; cost categorizations vary. Although major DoD contractors must obtain approval of their accounting systems from the Defense Contract Management Agency (DCMA), there is no single "right way" to report subcontractor labor and material costs, to differentiate direct from indirect costs, or to draw the line between recurring and non-recurring costs. Secondly, cost-reporting requirements vary by contract: Lower-tier vendors tend to provide basic components and services, often via fixed-price contracts. Subcontractors higher in the chain tend to deliver more complex services; these are often contracted via cost-plus vehicles. Cost-plus contracts generally call for more cost-reporting detail than do fixed-price contracts.

Data-completeness issues arise when costs are captured and reported via multiple contracts. When programs extend over years or decades, the clarity and completeness of cost data are clouded when performing entities change, whether via corporate reorganization or recompetition. Additionally, valid comparisons of contractor-led efforts to DoD-led efforts require the inclusion of government costs that are not often quantified. For instance, DoD "overhead" costs, such as the contracting office, are commonly overlooked in make-or-buy decisions. (Since overhead functions are reflected in an agency's cost structure whether or not services are used, they are often viewed as cost-neutral.) This tendency may be changing, however, since the Accountability in Contracting Act of 2007 calls for fully burdened costs when comparing internal sourcing to contracting out (Lumsden, 2007).

Other obstacles to the quantitative analysis of alternative strategies stem from the temporal nature of cost estimates and budgets for complex, long-duration efforts. Cost estimates for major programs reflect production quantities, schedules, and efficiencies ostensibly gained with experience. Over time, these tend to change. Over long periods of time, they change markedly. The researcher also found differences among budget figures (DoD, 2009b). When comparing budget exhibits for the Navy's Cooperative Engagement Capability system, figures differed

sharply among programs. This is likely due to differing assumptions and cost-sharing arrangements negotiated by the various program offices.

Further research is needed to illuminate the public-domain data. Personal interviews with program staff, as well as with DCMA, can provide insight for DoD in managing acquisition more astutely.

GAO (2005) confirmed that, while differences in magnitude and sources of cost growth exist, all shipbuilding programs experienced cost growth (Table 1). Programmatics (e.g., design challenges, schedule delays, business projections, and workforce issues) triggered the growth. Of the programs studied, the Virginia class of submarines was most closely aligned with the LSI model. GAO concluded that its cost growth was greater than that for some Navy-led programs, but less than that for other Navy-led programs. It can be inferred that LSI-like strategies, taken alone, are not good predictors of cost growth. Interrelated rival causes are detailed throughout GAO's analysis (Table 2).

TABLE 1. MAGNITUDE OF COST GROWTH, BY SHIP OR SUB, AND PRIME CONTRACTOR

	DDG-91	DDG-92	CVN-76	CVN-77	LPD-17	LPD-18	SSN-774	SSN-775
% of Cost Growth	10%	20%	14%	13%	139%	95%	27%	37%
$ of Cost Growth	$35M	$71M	$424M	$434M	$896M	$373M	$273M	$404M
Prime Contractor	Ingalls	Bath Iron Works	New-port News	New-port News	Avon-dale	Avon-dale	Electric Boat	New-port News

Source: GAO-05-183 (February 2005)

Identified as a lower cost-growth program, the Arleigh Burke class was built by Ingalls and Bath Iron Works (BIW), while the Navy retained design control. Ingalls reported growth in labor costs, linked to inexperienced workers and design upgrades. When assimilated into Northrop Grumman, Ingalls realized some economies on material costs, but overhead costs rose due to pension plans, medical benefits, and workload delays driven by new programs. BIW's labor costs were also driven up by design upgrades; its overhead costs increased due to medical-benefits costs and workload delays. Also noted as a lower cost-growth program, the Nimitz class was produced by Newport News Shipbuilding. Labor costs rose due to talent

TABLE 2: SHIPBUILDER COST CATEGORIES AS PERCENTAGE OF OVERALL COST GROWTH

	DDG-91	DDG-92	CVN-76	CVN-77	LPD-17	LPD-18	SSN-774	SSN-775
Labor Direct Labor Indirect Labor Costs	105	66	35	42	33	48	55	42
Materials Steel, copper, titanium Tooling & misc. parts Subcontractors	-49	23	46	31	47	24	49	49
Overhead Insurance Pensions Holiday pay Facilities & utilities Taxes	44	11	19	26	20	28	-3	9
Navy-Furnished Equipment Weapons Electronics Propulsion equip.	not cited		not cited		not cited		not cited	
Total	100	100	100	99	100	100	101	100

Source: GAO-05-183 (February 2005)

shortages, overtime, design changes, and late material deliveries. Material cost increases were tied to specialty materials and subcontracting. Overhead costs grew due to accounting changes, medical-care costs, capital investments, pension plans, and workload changes.

The highest cost-growth program was the San Antonio class of ships, built by Northrop Grumman. Labor costs increased due to design difficulties, schedule delays, and labor shortages. Material costs were increased by subcontractor efforts and tool development costs. Overhead costs were driven up by pension plans, workload losses, and schedule changes.

For the Virginia class, on which Electric Boat was Design Agent, the drivers of cost growth were similar to those on Navy-led programs: design issues, schedule volatility, material cost increases, overhead-rate changes, and workload fluctuations. These sources of cost growth are obviously not unique to LSI-type arrangements.

RAND (2006), which also assessed cost escalation for naval ships, corroborated GAO on root causes. RAND attributed cost growth to economy-driven factors (pension plans, labor rates) and customer-driven factors (design changes, schedule changes). Both RAND and GAO highlight the notion that cost growth is exacerbated by lack of "perfect information" (from traditional economic theory), particularly at program inception (Downs, 1964).

METHODOLOGY 2: QUALITATIVE ANALYSIS INTEGRATED WITH NETWORK THEORY

Many analysts believe that expertise comes from the private sector, but power resides in the public sector. This logic is sound from a pure, follow-the-money perspective: Public organizations exert power by funding private companies to carry out their missions. However, when private firms act as government agents, spearheading efforts involving a diverse cast of players, this view is oversimplified. The author drew from network and complexity theory (Goldsmith & Eggers, 2004; Agranoff, 2007) to explore relationships among entities in LSI-like arrangements.

Within the social sciences, complexity theory presents organizations as learning organisms that launch agents on non-linear feedback loops, acting interdependently with little intervention from controlling entities. Such networks of agents engage in cooperative behavior, eventually flattening hierarchies. These ideas counter the command-and-control mentality so integral to DoD culture. Still, this positive self-direction is motivated by feedback from other actors, as well as the environment. The more involved agents become in challenging work, the stronger connections become, making the (decidedly non-linear) process easier the next time.

While the network construct highlights the enduring nature of human intelligence and ambition, it fails to address some interactions among private and public organizations. Underlying all business arrangements are profit motivations, information asymmetry, and power. Synthesizing the literature, the following arguments can be made for Design Agent, LSI, and TSPR relationships:

- **Brainpower.** Private-sector talent can compensate for shortfalls in the DoD workforce.
- **Streamlining and agility.** Contractors can organize more efficiently to coordinate complex programs. Less bound by rules and traditions, they can adroitly assemble the required mix of talent.

On the other hand, contracting out vital functions has downsides, such as clashes over data rights and friction among LSI subcontractors and

customers. While some information exchanges move fluidly through the LSI hierarchy, each company is subject to financial and legal barriers that cannot be crossed.

1. **Erosion of government expertise.** Long-term programmatic knowledge may be sacrificed when contractors provide technical leadership.
2. **Checks and balances.** Communications protocol and decision-making processes are seldom adequately articulated in contractual terms and enacted via daily interaction (e.g., if the government has statutory rights to do independent testing, how does this mesh with the contractor's test plans?).
3. **Interpretation problems.** Prime contract requirements are not always conveyed accurately to subcontractors; this becomes progressively more difficult at each lower level on the supply chain.
4. **Culture change.** Ongoing education on roles and responsibilities in non-traditional arrangements is needed, and can obstruct open dialogue.
5. **National team concept.** With geographically dispersed industry teams, causes of technical problems are sometimes hard to pinpoint. Internal strife associated with jockeying for future scope and funding is another risk.
6. **Increased scrutiny.** In Congressional budgets, LSI-like arrangements appear as a single program element, rather than dozens of smaller ones. More scrutiny, albeit with less detailed understanding, is applied at the top level.
7. **Organizational conflicts of interest.** As members of an LSI team with common program objectives, individuals must share a great deal of information. Today's collaborators may be competing against one another for follow-on work, so firewalls are often erected within and among entities.
8. **Profit pressures.** Minor problems are sometimes downplayed until design and development efforts are complete (Baron, 2007). Over time, minor issues can lead to protracted delays, cost overruns, and program failure (Ratnam, 2001).
9. **Concentration of power.** The limited pool of LSI-capable companies may negatively impact innovation, diversity of subcontractors, and fair business practices.

Both theory and experience suggest that mid-1990s Acquisition Reform initiatives have compromised DoD's ability to coordinate and control its programs. The outsourcing of key management and technical functions may lead to a long-term loss of institutional knowledge. Moreover, outsourcing without strong oversight seems to have diminished

the degree of meaningful cost and performance data from the actual performers (i.e., subcontractors and suppliers to the LSI), negatively impacting DoD's leverage in negotiating and executing its acquisition programs. Of course, all nine of the preceding delineated disadvantages can be overcome by strengthening the government program office. Conversely, the espoused advantages of contractor-led efforts can also be maximized by a smarter, more efficient, less rule-bound DoD organization, particularly in the interrelated areas of program, business, and human resources management.

PROGRAM MANAGEMENT

In contracting relationships, DoD expects commitment and competence from private firms. However, DoD must possess enough capability internally to ascertain whether those expectations are being met. As Goodsell states, "in-house mission control" is needed to: (1) interact responsibly with contractors, and (2) exercise due diligence. Crawford and Krahn (1998) corroborate the need for a solid, balanced relationship: Key ingredients are: (1) a competent government customer, and (2) consistent oversight. This requires not just the technical proficiency to formulate a vision (Prencipe, Davies, & Hobday, 2003), but also the energy to enforce the terms of the contract. In other words, the government must not only have high standards; it must also remain steadfast in holding contractors to those standards.

Certainly standards and steadfastness are both hard to maintain, but mustering the strength to hold contractors accountable is the more difficult. In light of the author's experience in both hemispheres of the DoD acquisition world, this rings especially true. DoD employees are generally entrusted with greater responsibilities; yet they are confronted with more obstacles, such as cumbersome procurement processes, antiquated office equipment, inadequate staffing, ineffective personnel systems, and more compressed pay scales than those found in industry. Rainey and Steinbauer (1999) echo that: Public organizations are noted for lethargy precipitated by red tape. Much can be overcome, though, if key employees are committed to making a positive difference.

HUMAN RESOURCES MANAGEMENT

Success is often stymied by efforts to balance effective operations with control using democratic processes. Government managers can be discouraged by constraints, engaging less than vigorously in motivating subordinates and support contractors, in optimizing workflow and communication, and in carrying out their missions. Reasons for this are myriad: inexperience, relatively short terms in their positions, complicated

laws and regulations, diffusion of responsibility, and limited incentives (Rainey, 2003).

Crawford and Krahn suggest that government does poorly with acquiring, retaining, organizing, and channeling technical competence. To attract and retain technical talent, Asch (2005, pp. 309–342) advocates pay-for-performance systems with a base-plus-incentive-pay plan, and individual plus group incentives. Public-sector longevity can also be encouraged via pay structures that differentiate more with each successive pay band: Simply put, extra responsibility should carry more compensation.

BUSINESS MANAGEMENT

The right incentives, coupled with human energy, sacrifice, teamwork, accountability, and a healthy work environment, lead to program success (Baron, 2007). These factors emanate, at least partially, from competitive zeal. People want to be successful, and will try to attain their goals rationally (Downs, 1964). Extending notions of rationality and utility maximization from the individual to the collective, organizations must compete for work within their competencies, and identify others for work that does not fit. For example, Gholz (2004) suggests that smaller organizations, with lower overhead costs and financial pressures, are well positioned to conduct analyses and small-scale experiments (Ratnam, 2001). Likewise, free of future production and profit interests, Federally Funded Research and Development Centers (FFRDCs) and DoD laboratories could capably serve as LSIs.

Contracting, whether with FFRDCs, small businesses, or large corporations, is integral to the way DoD carries out its mission. As such, efforts should be made to recruit and retain professionals capable of: (a) setting goals and developing strategy; (b) inspiring those doing the work with commitment, enthusiasm, and a sense of public purpose; (c) monitoring technical work and financial data; (d) managing interfaces between contractor and end-users, as well as the external environment; (e) identifying and mitigating risk; (f) instituting a rigorous award fee process; (g) finding ways to back-load contractual incentives, so that performance will be rewarded at the end of the effort; and (h) conducting meaningful analysis to support negotiations.

Conclusions

Clearly, change is imminent. The Weapon Systems Acquisition Reform Act of 2009, coupled with recent legislation on LSI-type contracts, was stimulated by rhetoric on runaway costs, schedule disruptions, and contractor performance issues, as well as the ever-present scarcity of

resources. A full-scale rebalancing of risks and rewards is needed for DoD to improve the way it does business. Proposals include stronger government roles throughout development, more time between the development and production phases, fewer design changes, and standardization of engineering plans. These ideas call for wholehearted investment in program, business, and human resources management—all key competencies, regardless of the acquisition strategies currently in vogue. DoD must attract, develop, reward, and retain motivated, experienced, reflective practitioners.

Author Biography

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ACHIEVING OUTCOMES-BASED LIFE CYCLE MANAGEMENT

Lou Kratz and Bradd A. Buckingham

Over the course of 60 years, DoD has attempted to improve its acquisition and life cycle process through a series of incremental changes to address requirements creep, cost growth, funding instability, and technical risk. Unfortunately, these innovations have not improved cost, schedule, or technical performance of DoD programs. Currently, the United States faces significant economic and national security threats from near-peer competitors, rogue states, and transnational terrorist organizations. This multiplicity of threats requires an agile, cost-efficient process to mature and sustain military capabilities. This article explores fundamental changes needed within government and industry to evolve a highly agile and responsive life cycle process.

Keywords: *Acquisition, Logistics, Effects-Based Requirements, Industry-Government Partnerships, Commercial*

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Background

The Department of Defense (DoD) acquisition and sustainment processes are straining under the demands of the Global War on Terror and an emerging shortage of skilled acquisition and sustainment professionals. Significant cost and schedule growth, extended development cycles, schedule delays, elongated logistics response times, and increasing backorders are evidence of those strains. The Government Accountability Office (GAO) documented a 36 percent cost growth for major defense acquisition programs and characterized DoD logistics as high risk (Government Accountability Office [GAO], 2008). Additionally, the DoD continues to struggle to keep pace with and develop new technologies, and is no longer the catalyst driving the development of new revolutionary technology (Hagar, 2008).

In July 2008, the Defense Science Board (DSB) issued its report, “Creating an Effective National Security Industrial Base for the 21st Century: An Action Plan to Address the Coming Crisis.” The report provided specific recommendations to enable the DoD to achieve lower costs, field capabilities faster, and improve logistics support. The DoD also issued revised guidance on implementing a life cycle management framework that focuses on life cycle metrics, aligning resources and readiness, and implementing performance-based life cycle product support (Young, 2008). In March 2009, the Chairman of the Joint Chiefs of Staff (CJCS) issued CJCS Instruction 3170.01G. The intent of the revised guidance on the Joint Capabilities Integration and Development System was to improve the requirements process (CJCS, 2009).

The Weapon Systems Acquisition Reform Act of 2009 is the most recent attempt to reform the DoD acquisition and life cycle process. The act includes provisions to enhance oversight, foster independent cost estimates, and improve the DoD acquisition workforce. These provisions are directed toward addressing DoD’s challenges with requirements, stability, cost growth, and schedule delays.

Our current national security posture and budget realities dictate that DoD and industry continue to explore and refine new acquisition and sustainment processes to enable greater agility and capability at reduced costs. To appreciate the challenges DoD faces in achieving that agility, one must first review the path that DoD and industry have traveled since World War II.

THE WORLD WAR II ACQUISITION AND LOGISTICS ENVIRONMENT

The acquisition process during World War II focused on mass production of weapon and support systems, as the American economy served as the heart of the Allied war effort. The United States produced over 2.4 million vehicles, 88,000 tanks, and 303,000 aircraft during

the war, with the lend-lease program exporting $57.4 billion worth of equipment to its Allies. U.S. production exceeded that of the Allies and adversaries combined (Dana, 1998). The ability of the U.S. industrial base to rapidly transition from civilian to defense production enabled the Allied victory in World War II (Dana, 1998).

ACQUISITION AND LOGISTICS DURING THE COLD WAR

In 1945, U.S. industrial capacity transitioned from a wartime footing to a commercial market burgeoning with pent-up demand. Commonality in manufacturing processes, similarity in products, and a dramatic increase in demand for consumer durables made for a relatively smooth transition to a peacetime, consumer-driven economy.

The subsequent emergence of the Soviet Union as a peer competitor gave birth to a dedicated defense industry that focused on developing and manufacturing the increasingly complex systems needed for deterrence (Defense Science Board, 2007). Weapon systems acquisition during this period displayed several market characteristics:

- A monolithic threat enabled the United States to concentrate on relatively stable and predictable requirements.
- A national decision to capitalize on technology to seize and maintain qualitative superiority led DoD and industry to concentrate on equipment performance.
- A robust set of industrial competitors enabled DoD to experiment, develop, and prototype needed technologies while capitalizing on competitive market forces.
- A national decision to forward-deploy forces in Europe and Korea encouraged large logistics footprints of supplies, personnel, and maintenance facilities to also be forward-deployed.
- A national will supported DoD efforts and provided funding at approximately 5–15 percent of the GDP (Center for Strategic and Budgetary Assessments, 2006).
- A supportive environment of exploratory technology tolerated test failures and allowed new data findings.

The DoD and industry became increasingly governed by unique government practices—first in engineering and manufacturing, then in finance and business—with the DoD specifications and standards numbering 30,000 by 1980 (Poston, 2003). These specifications and standards drove a wedge between defense and commercial industries and served as significant barriers for non-defense firms trying to enter the defense market.

The continuing DoD challenges with requirements stability, technical/risk management, funding stability, and the lack of schedule adherence produced a national will that after three decades of Cold War, began to demand more efficiency and accountability within defense acquisition and logistics.

THE REAGAN ERA

Beginning in the early 1980s, a series of incremental policy directives attempted to address skyrocketing weapons costs and increasing development schedules. In April 1981, Deputy Secretary of Defense Frank Carlucci presented 32 initiatives for reducing weapon systems costs, shortening development time, and improving weapons readiness and support (Carlucci, 1981). One goal of the initiatives was to control cost growth by attempting to achieve realism in cost estimating.

Secretary Carlucci also introduced the concept of Preplanned Product Improvement (P3I)—a means to deploy systems and sequentially upgrade them over time (Carlucci, 1981). This strategy was intended to minimize technological risk, and quicken the pace of modernization of the nation's armed forces. Other recommendations included the production of weapon systems at more efficient rates, reduction in the number of DoD directives, more advantageous use of competition, and greater use of standardized subsystems and support equipment. These initiatives represented a comprehensive list of measures with the potential to lower costs, but did not address the major causes of cost growth in weapon systems such as technical risk, requirements creep, and cost-plus business arrangements (Foelber, 1982).

During this period, Congress also took steps to curb the rising cost of weapon systems, including the introduction of more rigorous DoD reporting requirements, the establishment of audit procedures for acquisition activities, and wider use of multi-year contracts (Lockwood, 1983).

THE PACKARD COMMISSION

President Reagan established the Packard Commission in 1986 to reduce the inefficiencies in the defense procurement system, with an emphasis on the acquisition process. The Commission's conclusions supported the results of numerous prior studies, reporting that the acquisition process suffered from schedule delays, cost overruns, and inefficient performance (The President's Blue Ribbon Commission on Defense Managment, 1986). The Commission recommended streamlining the acquisition process, increasing the amount of tests and prototypes, and improving planning.

A subsequent review of 269 completed defense contracts found that the Packard Commission's recommendations were ineffective in

reducing cost overruns. Despite implementing over two dozen initiatives, no considerable progress in defense program cost performance was realized for over 30 years (Christensen, Searle, & Vickery, 1999). The recommendations did little to fundamentally change the DoD acquisition system that favored expensive, long programs, as shown in Table 1.

TABLE 1. THE EFFECT OF PACKARD COMMISSION RECOMMENDATIONS ON DEFENSE COST PERFORMANCE

		Contract Phase		Managing Services		
	All Contracts	Development Contracts	Production Contracts	Air Force	Navy	Army
Number of Contracts (n)	269	8	188	113	134	22
Final overrun before imple-mentation (%)	5.6	4.1	6.2	2.8	7.6	8.1
Final overrun after imple-mentation (%)	9.5	15.3	7.2	12.7	6.1	17.0
Difference (%)	3.9	11.2	1.0	9.9	-1.5	8.9
Statistical significance (p)	0.055	0.014	0.294	0.003	0.206	0.110

(Christensen, Searle, & Vickery, 1999)

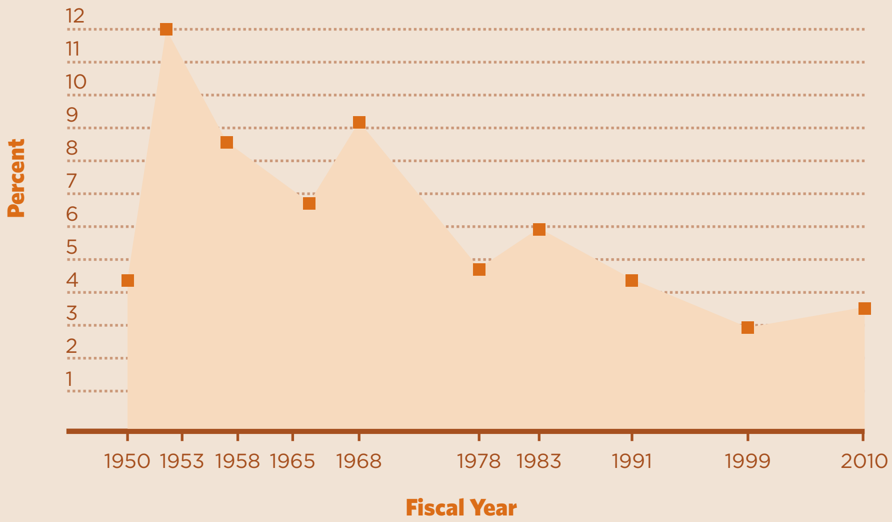
HISTORIC FUNDING

Figure 1 presents defense outlays as a percent of gross domestic product. As shown, defense spending has continuously declined from 1950 through the present. The recent spike, associated with the Global War on Terror, is projected to decline in the outyears, placing increased pressure on DoD modernization accounts.

THE END OF THE COLD WAR

By the end of the Cold War an industrial structure, an acquisition process, and a logistics system existed that was mismatched with the priorities of the American people and the global security environment. The DoD had honed an acquisition process that focused on providing technologically superior systems with industry geared up to produce those systems in large quantities. With the dissolution of the Soviet Union, the American public shifted its priorities to domestic issues. Multiple

FIGURE 1. DEFENSE OUTLAYS AS A SHARE OF GROSS DOMESTIC PRODUCT



(Lewis & Mehuron, 2009)

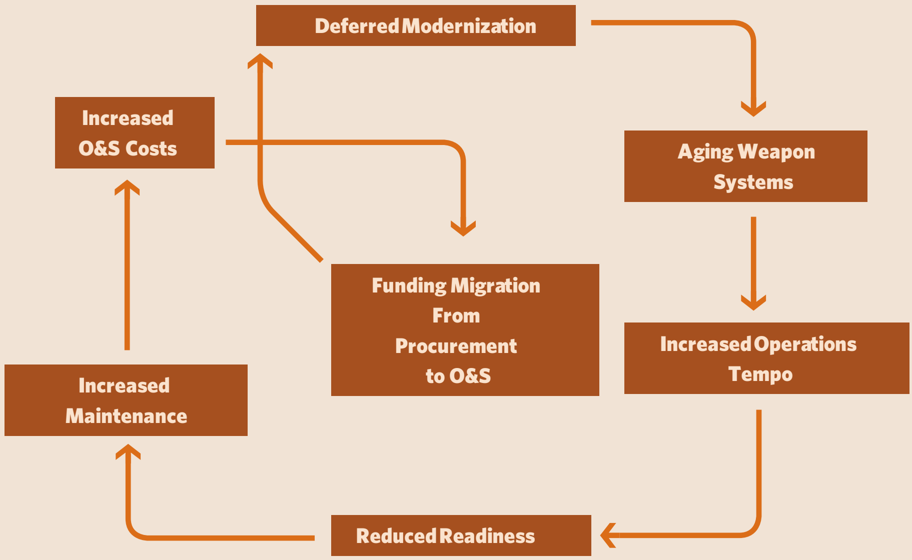
administrations, through the 1990s, responded to this shift in focus through force reductions, base closures, and industrial consolidation (GlobalSecurity.org, 2003).

SPECIFICATIONS AND STANDARDS REFORM

In 1994, Secretary of Defense William Perry issued DoD policy to increase access to state-of-the-art technology and adopt the same business practices as world-class commercial suppliers. The directive attempted to reduce the complexity and costs that DoD incurred when purchasing major weapon systems and their numerous maintenance requirements.

Secretary Perry chartered a detailed cost analysis allowing the DoD to determine the most important cost drivers in the quest for standards reform. The study concluded that, on average, the DoD paid a regulatory cost premium of approximately 18 percent. The study also indicated that significant cost savings were achievable through reductions in DoD regulation and oversight (Coopers & Lybrand/TASC Project Team, 1994). Since Secretary Perry introduced his plan to reform the acquisition process, over 1,200 commercial standards have been adopted by the DoD; however, DoD has not fully capitalized on commercially available solutions (Office of the Secretary of Defense, 1994).

FIGURE 2. THE DoD "DEATH SPIRAL"



(Gansler, 1998)

The procurement accounts declined in the late 1990s, with fewer new systems under development and existing weapons platforms continuing to age and remain in service well past their intended life cycles. This extended use resulted in increasing operations and maintenance (O&M) costs, which contributed to a life cycle "Death Spiral" of further deferred modernization, as shown in Figure 2 (Gansler, 1998).

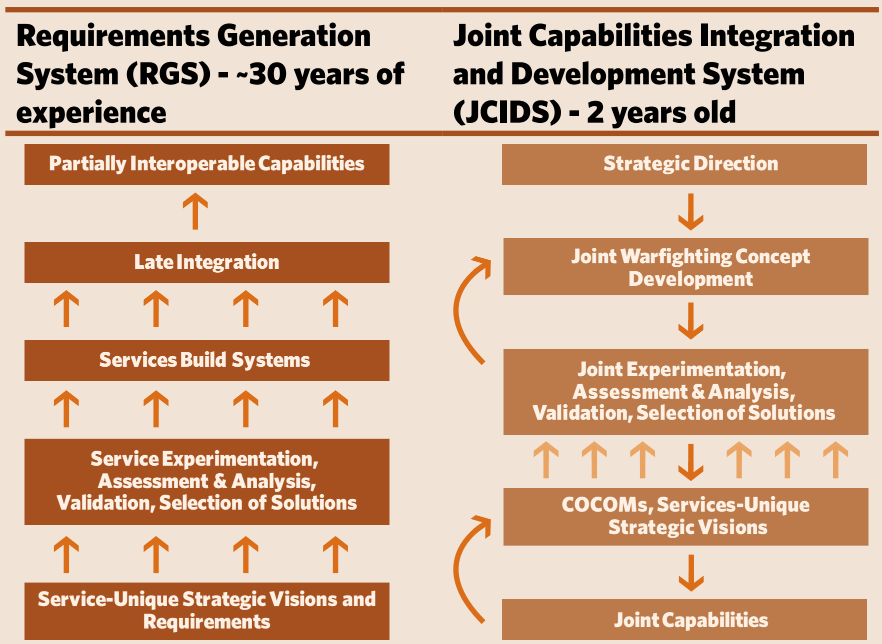
To attack this "death spiral," Secretary Gansler launched an aggressive acquisition and logistics reform effort (Gansler, 1999). Key initiatives included increased use of commercial items, evolutionary acquisition, streamlined acquisition documentation, and performance based logistics. These initiatives emphasized greater civil-military integration and were directed towards increasing acquisition and logistics agility.

JOINT CAPABILITIES INTEGRATION AND DEVELOPMENT SYSTEM (JCIDS)

The Joint Capabilities Integration and Development System (JCIDS) was created in 2003 to address shortfalls in the DoD requirements generation system. Identified by the U.S. Joint Chiefs of Staff, these shortfalls included not considering new programs in the context of other programs, not sufficiently considering combined service requirements, not effectively prioritizing joint service requirements, and not accomplishing sufficient analysis.

The JCIDS process codifies a DoD policy shift away from threat-based assessments to capabilities-based assessments of warfighter needs. As

FIGURE 3. THREAT VS. CAPABILITY-BASED PLANNING



a replacement for developing, producing, and fielding systems based on perceived threats to the nation, JCIDS policy enables the development of capabilities based on strategic direction and priorities defined in the National Military Strategy and National Defense Strategy, as shown in Figure 3 (Chadwick, 2007).

THE GLOBAL WAR ON TERROR

Despite the perceived "peace dividend," the migration from a bi-polar world to a multipolar world proved more challenging than anticipated. The DoD continued to rely on acquisition processes, organizations, and infrastructure largely developed in the years following World War II. Technical superiority had proven successful against a peer competitor; however, rapid advancement in commercially available computing and telecommunications empowered multiple new threats; e.g., transnational terrorism and rogue state actors. This multiplicity of threats demanded greater agility and innovation at the same time DoD acquisition and its associated industrial base were contracting. The Global War on Terror (GWOT) has provided the United States lessons directly related to DoD acquisition and sustainment. These lessons include:

- Our requirements process is slow to react to a rapidly adaptive adversary.

- Our acquisition process consumes billions of dollars against threats generated at a fraction of that cost.
- Our mass logistics structure is insufficient to support rapid, dispersed forces.

In September 2008, Secretary of Defense Robert Gates spoke at the National Defense University and addressed these issues:

> The need for the state-of-the-art systems—particularly longer range capabilities—will never go away, as we strive to offset the countermeasures being developed by other nations. But at a certain point, given the types of situations we are likely to face—and given, for example, the struggles to field up-armored HUMVEES [High Mobility Multipurpose Wheeled Vehicles], MRAPs [Mine Resistant Ambush Protected (vehicles)], and ISR [intelligence, surveillance, and reconnaissance] in Iraq—it begs the question whether specialized, often relatively low-tech equipment for stability and counterinsurgency missions is also needed.

Secretary Gates continued:

> Why did we have to go outside the normal bureaucratic process to develop counter-IED [improvised explosive device] technologies, to build MRAPs, and to quickly expand our ISR capability? In short, why did we have to bypass existing institutions and procedures to get the capabilities we need to protect our troops and pursue the wars we are in? Our conventional modernization programs seek a 99 percent solution in years. Stability and counterinsurgency missions—the wars we are in—require 75 percent solutions in months. The challenge is whether in our bureaucracy and in our minds these two different paradigms can be made to coexist.

TIME FOR CHANGE

The answer to Secretary Gates' question can be found in the historic evolution of our nation's DoD life cycle process. Since the end of World War II, the DoD developed and refined an acquisition process focused on responding to a predictable, monolithic threat. This process built upon several underlying principles, including a desire for U.S. technological superiority, a competitive industrial base, and a relatively long planning and requirements horizon.

Over the course of 60 years, DoD attempted to improve its acquisition and life cycle process through a series of incremental changes to address requirements creep, cost growth, funding instability, and technical risk. Despite numerous studies and reforms, these incremental efforts did

TABLE 2. GEOPOLITICAL DIFFERENCES

1945—1990	Today
Threat: Bipolar threat. Enabled the United States on relatively stable and predictable requirements (Soviet Union)	**Threat:** Multipolar threat. Transnational terrorism, near-peer competitors, and rogue state actors
Technology: A national decision to capitalize on technology to seize and maintain qualitative superiority led DoD and industry to concentrate on equipment performance. Military technology as the driving force	**Technology:** DoD no longer the catalyst driving the development of new revolutionary technology. Commercial technology the driving force
Requirements: Concentrated on relatively stable and predictable requirements. Match or counter Soviet weapons systems	**Requirements:** Unpredictable and unstable with the multiplicity of threats and behavior. Adversaries with current events driving requirements
Acquisition & Sustainment: A robust set of conventional industrial competitors enabled DoD to experiment, develop, and prototype needed technologies while capitalizing on competitive market forces. Incremental change	**Acquisition & Sustainment:** Systems and cost demands of the Global War on Terror, increasing Congressional oversight, and a shortage of skilled acquisition and sustainment professionals. Significant cost and scheduled growth of major defense programs, extended development cycles, schedule slips, elongated logistics response times, and increasing backorders
National Will: A national will that supported DoD efforts and provided funding at approximately 5—15% of the Gross Domestic Product	**National Will:** National will skeptical and increasingly unwilling to accept continued rampant defense spending

not improve cost/schedule control nor provide the inherent agility that is required.

The geopolitical environment that underlies DoD's acquisition and logistics processes has fundamentally changed over the past 60 years, as summarized in Table 2. These dramatic changes dictate that DoD develop an acquisition and life cycle process that is efficient and agile to respond

to current threats. Such changes cannot be achieved via incrementalism because the fundamental—the underlying principles—have changed.

Over the last two decades, the nature of conflict has fundamentally changed, and much of America's defense establishment has yet to adjust to the security realities of the post-Cold War world and the complex and dangerous new century. The acquisition and logistics environment of the 21st century needs a course of action that will decisively enable greater agility and efficiency. Such agility might be achievable by returning to our historic reliance on a competitive, integrated industrial base (such as we enjoyed prior to and during World War II). That reliance could be enhanced by:

- Establishing a top-down, competitive requirements process that fosters competing alternative solutions and industrial innovation
- Implementing a product development process that builds upon inherent industry incentives and product investment
- Defining a product support logistics model that is focused on readiness and capitalizes on best-in-class practices in government and industry.

The potential effects of these changes are contrasted to incremental efforts in Table 3.

Becoming Highly Agile and Responsive

EFFECTS-BASED REQUIREMENTS

"Requirements creep" has been a persistent problem within defense acquisition since World War II. This "creep" is driven by the DoD focus on technological superiority and the military services historic bias towards unique requirements. The JCIDS process (and subsequent portfolio management) was intended to correct these problems; however, the Joint Staff was never fully resourced to develop capstone and integrating concepts. As a result, the JCIDS process continues to be dominated by Service-driven requirements. The most recent Chairman Joint Chiefs of Staff Instruction (CJCSI) 3170.01G re-emphasizes those relationships by establishing the sponsoring agent (Services) as responsible for creating requirements documents, while the Joint Staff and Combatant Commanders (COCOMs) are responsible for review and coordination.

For DoD to enhance agility, it must begin with a *top-down* requirements process that is appropriately focused on the military effort that is required. Requirements would be characterized based upon desired effect

TABLE 3. SUMMARY TIMELINE FOR ACQUISITION AND LOGISTICS CHARACTERISTICS AND OUTCOMES

	Acquisition and Logistics Characteristics		**Acquisition and Logistics Outcomes**		
Reform Attempt	Strengths	Weaknesses	Capability	Agility	Efficiency
Packard Commission	Attention to acquisition streamlining	Expensive, lengthy acquisitions continue	Yes	No	No
Specifications/ Standards Reform	Best commercial practices	Modernization "death spiral"	Yes	No	No
Joint Capabilities Integration and Development System (JCIDS)	Capabilities based on joint warfighter needs	Disconnect between born joint and employed joint	Yes	No	No
The Weapon Systems Acquisition Reform Act of 2009	• Independent cost estimates • Strengthened oversight • Improved DoD workforce	No inherent performance incentive	Yes	No	No
		Future Strategies			
Effects-Based Requirements	Innovation and industry competition		Yes	Yes	Yes
Industry Driven Research & Development (R&D)	Leverage commercial R&D		Yes	Yes	Yes
Industry-Provided Life Cycle Process Services (LCPS)	Successful partnerships with DoD providers		Yes	Yes	Yes

or outcome, rather than as a specific system. The proposed top-down process would include the following:

- Functional Capabilities Boards would prepare the Initial Capabilities Document (ICD) based upon input from the COCOMs. By their nature, these ICDs would focus on military need and effect.
- The ICD would be approved by the Joint Capabilities Board (JCB) and the Joint Requirements Oversight Council (JROC).
- The ICD would then be provided to all DoD sponsoring agents to assess/consider alternative solutions to the ICD. These efforts would include competitive industrial participation during Material Solutions Analysis (MSA).
- The potential sponsoring agents would present the results of their efforts and a draft capability development document (CDD) to the JCB and JROC to select a preferred solution.
- Once approved, the CDD would form the basis for a Material Solutions Board (MSB) decision to proceed with a program.

This proposed process would strengthen the Joint Staff and COCOM role in requirements development and would require additional analytic resources within the Joint Staff. The process also would foster competitive evaluation of alternative solutions and enhance innovation.

Effects-based requirements would make maximum use of Joint Staff resources for integrated "Concepts of Operation," while fostering innovation within the Services and industry to develop competing solutions. Industry would be empowered to provide a specific capability rapidly, within the constraints of the Concept of Operations.

COMMERCIALLY DRIVEN RESEARCH AND DEVELOPMENT

The DoD acquisition process reinforces unique solutions via built-in-bias for large, long, cost-plus development programs. These programs inherently embody incentives for cost and schedule growth and limited incentives for efficiency. DoD and the Congress have attempted to regulate efficiency for 20 years via increased oversight and reporting, but the overall process is impervious to incremental change.

Currently, the defense industry develops a customized product with capabilities specified in advance for the individual Services. The DoD bears the up-front investment in development costs. This process incentivizes industry to pursue a technological track driven by projected performance, with limited incentives to enhance technology maturation or reduce risk. This is in stark contrast to the commercial product development process,

where industry invests in development costs with an equal emphasis on maturation and innovation (Dombrowski & Gholz, 2006).

The "new normal" of persistent conflict and stabilization engagement demands a new normal research and development business model. Advances in technology research and development (R&D) are currently led by the commercial world, where R&D has increased steadily at a rate of about 5 percent per year for more than 20 years. During this same 20-year period, DoD and government R&D spending dropped 2.5 percent per year (DoD, 2000). For DoD to capitalize on commercial investment, it must actively engage the commercial market.

The new R&D business model would be more akin to the commercial development process, where industry manages product R&D (and is fully responsible for technology maturation of that product). DoD would continue to invest in basic research within the 6.1 and 6.2 accounts, and in test and evaluation of competing prototypes. This would incentivize the defense industry to control requirements creep, select mature technologies for product integration, and develop solutions in an incremental, timely fashion. The model naturally incentivizes industry, as defense companies would be funding product development versus the cost-plus development of today. The result is a solid, business-driven mechanism that both moderates technical risk and ensures technical maturity (Gholz, 2007).

A consequence of increased control of R&D investment by the defense industry is that there will be times when the warfighter customer will not be interested in the technological improvements the defense industry has developed and offers for sale. To offset this, the defense industry and the warfighter will have to develop a strategic planning process that recognizes warfighter requirements and identifies desirable product improvements *before* developing a particular platform (Gholz, 2007).

Additionally, defense-related companies would increase their technological and market risk as they assume more responsibility for investment decisions, as they will be required to *put their own money on the line* to advance their technological core competencies. Similar to the commercial industry, defense-related companies would offer the products they have developed, with the development cost already included in the price—*prior* to offering them for sale to warfighters. The warfighters would then bear little technological risk, due to basic product performance characteristics already having been developed and well understood at the time of the sale (Gholz, 2007). Such a model would include the following key attributes:

- DoD-funded basic research and technology maturation through 6.1, 6.2, and 6.3a
- Industry engagement in competitive concept development via the revised requirements process

- Industry-funded product development following an MSA/B decision
- Government-funded test and evaluation, which, if successful, enables a full production decision.

This model may not be appropriate for multifaceted, high-risk weapons platforms, such as aircraft carriers or nuclear submarines. However, it should be appropriate for the system of systems that comprise these platforms, information technologies, and the growing number of items required for "persistent presence." This approach will require fundamental change within DoD to accept industry-matured technologies and equipment built to commercial standards.

OUTCOME-BASED PARTNERSHIP LIFE CYCLE PRODUCT SUPPORT

In the 2001 Quadrennial Defense Review, the DoD mandated the implementation of Performance Based Logistics (PBL) with the goal to gain the most efficient and effective performance of weapon systems throughout their life cycles, and to build successful business partnerships that align with the goals of all involved parties for the duration of these programs (Berkowitz, 2005). PBL is a business partnership model designed to align the interests of both the DoD and the logistics service provider, creating value and the desired outcomes of both partners. This yields a more cooperative venture than merely achieving Service-level agreements or getting the lowest price from the provider.

PBLs are employed across a broad range of systems, such as aviation tires, subsystems such as engines, and complete weapon systems (e.g., F-22). More than 200 PBL efforts are ongoing DoD-wide that have demonstrated material availability above 95 percent and commercial response times of 2-4 days (versus a DoD average of 16 days) (Estevez, 2006).

The dramatic change in the U.S. security posture from 1997 to 2001 provided significant real-world observations associated with DoD's PBL efforts. These include:

- When appropriately incentivized, *industry-government partnerships* can provide improved material availability at reduced costs while mitigating obsolescence, reducing inventory, and reducing demand.
- Performance based arrangements are complex and require a knowledgeable DoD life cycle workforce that has core competencies in all product support functions and full insight/oversight of contract and agreement execution.

- Performance based arrangements are successful at the component, subsystem, and system level, depending upon the unique circumstance of the system.
- Government should procure access and rights to system technical data to enable long-term sustainment and competition.
- DoD employs forces in a joint and coalition environment; thus, sustainment strategies must reflect enterprise as well as weapon systems requirements.
- Depot partnering integrated industry and government resources; however, partnering across other aspects of product support is difficult.
- Long-term contracts limit government flexibility to adjust to real-world changes; therefore, sustainment strategies must be agile and sufficiently flexible to enable DoD to adjust to operational demands and budget realities.
- Performance based arrangements are incentivized for the contractor to engineer reliability improvements into the system. The benefits are twofold: fewer repairs for the contractor and less remove-and-replace actions for the flight line maintainer.

These key observations form the basis for a revised product support business model that is responsive to today's threat environment, builds upon the best from government and industry, and reinforces transparency and accountability. Key objectives of such a model include:

- Outcome and performance-based across the life cycle, with full cost and performance transparency
- Contractual relationships that inherently include flexibility to adjust to real-world operational and budget dynamics
- Government-industry partnerships that span all product support elements and foster shared responsibility for integrated outcomes
- Improved portfolio and enterprise integration led by government capabilities
- Clear government accountability with associated insight/oversight of industrial providers
- Appropriate balance of government and industry providers that enables development and retention of government capability.

Combining these emerging aspects with previously demonstrated successes and observations yields a product support model that is effective, efficient, and flexible. Key elements of the model include:

- The program manager is the life cycle product support manager and the single point of accountability for readiness and cost.
- PBL successes of the past decade are improved upon, with a broader tool box of partnering solutions and flexible contract strategies.
- DoD owns rights and has access to all technical data necessary to support the system through its entire life cycle.
- DoD retains responsibility for configuration management following final design review. Industry provides configuration management services and status accounting.
- Product support service providers are re-assessed on a 5-year basis following the rate production decision.
- Government-industry partnerships are established for *all* product support elements early in the life cycle.
- Initial integrated logistics support analyses explicitly consider enterprise assets.
- Weapon systems product support information is integrated into overall enterprise information systems.
- Closed-loop health monitoring and prognostic capabilities are established to enable effective fleet management.
- Integrated logistics support and level of repair analysis are continuously re-evaluated based upon field experience provided by the closed-loop system.

The proposed model is a hybrid of current promising practices and, therefore, is dependent upon several key enablers, including:

- Establishing a comprehensive capability for the program manager to function as the life cycle manager, consistent with PM accountability and responsibility (although this is designated in policy today, the program management curriculum includes very little formal training in sustainment)
- Developing a robust government workforce of life cycle product support professionals who support the program manager
- Implementing transparent cost accounting systems within the government that inherently enable capturing and reporting costs on a weapon systems basis

- Creating appropriate management and oversight structures that enable organic providers to commit to programmatic and system-level outcomes
- Creating contractual mechanisms that enable government-industry partnerships while ensuring effective government oversight
- Defining appropriate and necessary information system interfaces that enable enterprise-wide transparency and visibility
- Enabling more transparent product support to the warfighter and more warfighter advocacy for affordable, readiness-based product support objectives.

These enablers address significant structural issues that will require statutory, policy, and business process changes. These changes may span over a decade.

Conclusions

Despite fond memories of past glories, cost and schedule control has been a persistent problem within defense acquisition since World War II. The DoD acquisition and life cycle processes have proven to be impervious to incremental improvements, despite decades of study and recommendations. It is certain that for the foreseeable future we as a nation will face a severely constrained fiscal environment that will put added downward pressure on defense and other discretionary budget elements. This uncertainty requires an acquisition process that is *agile* and *efficient*, enabling the DoD to rapidly field and sustain capabilities.

This situation necessitates an enterprise-wide Defense Department application of the proven life cycle management practices that will ensure greater performance improvements and simultaneous cost savings. These significant savings opportunities in turn can be deployed to address the significant force modernization and recapitalization requirements that we face today and in the future.

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PRE-MILESTONE A COST ANALYSIS: PROGRESS, CHALLENGES, AND CHANGE

Martha "Marti" A. Roper

The natural law of inertia: matter will remain at rest or continue in uniform motion in the same straight line unless acted upon by some external force.

Clement W. Stone

After three years of parallel research and application efforts aimed at enabling pre-Milestone A cost analysis, the time investment has produced dividends of progress and lessons learned for a team of Army researchers. Clearly, early acquisition investment decisions must be cost-informed, and the demand for this early cost information is growing. Although concrete tools are being developed to enable the analysis to support early investment decisions, it will not be achievable without an analysis culture with the policy, procedure, and willingness to develop and/or accept cost estimates that are less precise than those developed at Milestone B or Milestone C. Making early analysis a reality will require large-scale, department-wide culture change within and around the analysis community.

Keywords: *Pre-Milestone A, Cost Analysis, Acquisition Process, Joint Capabilities Integration and Development System (JCIDS), Analysis of Alternatives, Capability-Based Cost Analysis, DoDI 5000.02, Concept Decision*

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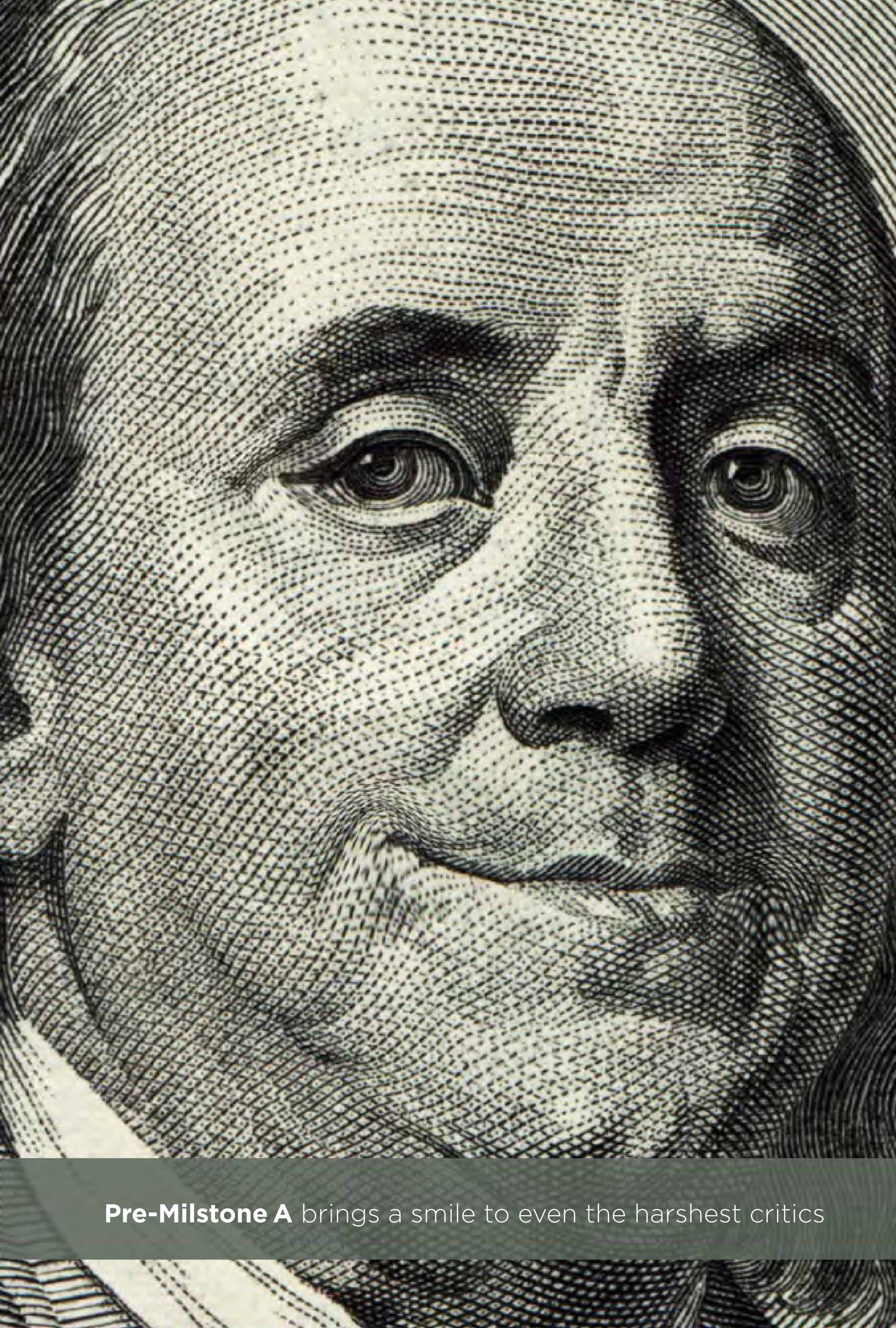


Pre-Milstone A brings a smile to even the harshest critics

Although Pre-Milestone A cost analysis is a relatively unfamiliar concept in defense analysis, its application is increasingly being researched and leveraged by a team of Army analysts at the Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE). Simply stated, a cost analysis aims to inform the decision-making process with specific types of information, namely measures in monetary terms of willingness to pay for a change by those who will benefit from it, and the willingness to accept the change by those who will lose from it. After three years of parallel research and application efforts, the team's time investment has produced dividends of progress and lessons learned. Clearly, early acquisition investment decisions must be cost-informed; and now more than ever, the demand for this early cost analysis information is growing.

But how can cost estimates be developed so early with so little system definition? Three major elements enable pre-Milestone A cost estimating. The first is an analysis framework that can make use of qualitative capability data (along with any physical, technical, and performance data available at that time) to produce a cost estimate. The second is a cumulative high-level cost data source that links systems to their capability sets. The third is an analysis culture with the policy, procedure, and willingness to develop and/or accept cost estimates that are less precise than those developed at Milestone B or Milestone C.

The first element, the capability-based analysis framework, has been developed and is being continuously refined and applied under the ODASA-CE internal research efforts (Roper, 2007a). The second element, the high-level capability mapping coupled to cost data, has been developed, populated, and is growing as more data become available (Roper, 2007b). The third element, however, is one that involves more than mere research and data collection. It requires large-scale, department-wide culture change within and around the analysis community. Clearly, without this third element, an ample supply of elements one and two alone will not enable capability-based, early cost estimating.

Observations and Lessons Learned

As a result of the 2004 Quadrennial Defense Review (QDR) emphasis on earlier investment decision making within the department, OUSD(AT&L) initiated the Concept Decision Experiment (2006-2008). This trial process took four pilot *capability sets* through a Concept Decision investment decision, where the key innovation was that the three key department stakeholders (or *Tri-Chair*)—acquisition, resourcing, and requirements—participated in the decision forum and committed (from their respective lanes) to whichever alternative(s) was selected.

An analysis process leading up to this event—the Evaluation of Alternatives (EoA)—supported the Concept Decision. It was similar to what is known as an Analysis of Alternatives (AoA) within DoD, except that it was broader, less granular, and included non-materiel solutions analysis. The evaluation and selection of an alternative was to be cost- and risk-informed, and coupled with some measure of how well the alternative filled the capability gap.

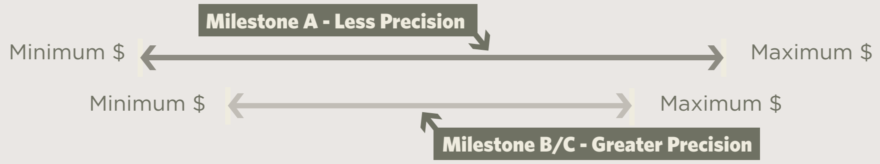
One of the main objectives of the Concept Decision Experiment was to enable early concept decisions that evaluate a trade space of materiel and non-materiel alternatives to fill capability gaps. A desired outcome of this early investment decision making is more stable defense acquisition programs. Although the Tri-Chair Concept Decision/EoA model was not adopted, some sweeping acquisition reform measures resulted from the experiment. Up until that point, most materiel solutions in the acquisition cycle were not required to be reviewed until Milestone B, effectively tailoring out the acquisition entry point and Milestone A.

In the aftermath of the Concept Decision Experiment, the Concept Decision point was recast as the Materiel Development Decision (MDD), a mandatory entry point to the acquisition process. At the MDD, the Milestone Decision Authority (MDA) determines to which milestone the solution/capability set proceeds. A clear and already evident result of this change is that many more Milestone A analyses are deemed necessary for solutions proceeding through the acquisition process. The AoA requirements remain relatively unchanged (from an analysis character point of view); however, due to the increased incidence of early-analysis Milestone A's, the use of AoAs has become much more prevalent. These changes were all formally instituted through the Department of Defense Instruction (DoDI) 5000.02 revision in December 2008.

PRECISION CONSIDERATIONS AT MILESTONE A

Intuitively, the primary focus of the ongoing Army research is how to enable early cost analysis (and its context). One of the terms used to describe the cost analysis required for an AoA at Milestone A is rough order of magnitude or *ROM* (DoD, 2006). However, the term ROM is problematic in that it has a well-understood mathematical definition that does not apply to the common DoD use of the term. A more accurate way to characterize cost analysis at or before Milestone A is to observe that the estimate range (indicating the range of probable costs) would be wider due to reduced system definition and greater uncertainty, as shown in the Figure. To date, no comprehensive effort is ongoing to characterize the form and expectation of pre-Milestone A analysis; therefore, great diversity in interpretation prevails across the department.

FIGURE. IMPACT OF SYSTEM MATURITY ON COST ESTIMATE RANGES



Probabilistically speaking, any one point estimate has a zero percent chance of being correct. As any cost analyst will confirm, risk analysis is an important element of any cost analysis result. On its own—and important to note—is that a pre-Milestone A point estimate is not very informative on its own—it must include a risk analysis or a cost range to capture the uncertainty associated with the estimate. As we add precision by adding system definition and/or analysis resources, our certainty around the associated point estimate will narrow. Intuition indicates that the range around the point cost estimate will narrow as we move from Milestone A to Milestone B to Milestone C (see Figure).

One analyst might believe a pre-Milestone A estimate is a range estimate based on one or more variables that gives a reasonable level of confidence. Another might believe it to be very similar to a Milestone B cost estimate (filling the many data gaps with assumptions), with the ability to perform detailed variable *what-if* drills. Clearly, an unambiguous definition is needed of what a pre-Milestone A estimate is and what level of analysis is considered acceptable. At or before Milestone A, if the system concept is at the level of maturity expected at that time (likely not well-defined), it would seem that the analysis should be something appreciably less detailed than at Milestone B. In fact, the level of system definition required to build a detailed cost estimate may not exist, or may require extensive *creative* assumption-making that may not be appropriate. Moreover, if the intent is to provide a way to distinguish between alternatives to inform prudent investment decisions, then a less precise estimate, coupled with risk ranges and measures, may be exactly what is required.

ENABLING DEPARTMENT-WIDE, CAPABILITIES-BASED COST ANALYSIS

Pre-Milestone A decision making often occurs in a data-poor environment. Prior to Milestone A, requirements or desired capabilities are known, but additional information is limited. Often, only general solution-type information is available. For cost analysis techniques to be relevant prior to Milestone A, they must take into account all available information. One method of dealing with this data-poor environment is to engage in capability-based cost analysis.

Capability-based cost analysis begins with the idea that system capabilities are related to system cost. Once a link between capabilities and cost is established for existent systems, this mapping can be used to estimate the cost of future systems based on their capabilities. If additional information is known or becomes available, it can be used to improve the estimate's accuracy. Capability data join physical, technical, and performance data as relevant data sources and bases for analysts' estimates.

Capability-based cost analysis and pre-Milestone A cost analysis are two distinct concepts. While the necessity of cost analysis during pre-Milestone A often requires the inclusion of capability-based cost analysis techniques, capability-based analysis has utility after Milestone A has come and gone. Capability-based cost analysis is relevant at all stages of a system's life cycle; it can aid in identification of analogous systems and methodology development whenever applicable and appropriate. To date, the focus of capability-based analysis has been to provide system acquisition costs. However, capability-based cost estimating can also derive costs for maintenance or disposal. Two main advantages of capability-based cost analysis are that it can be done with limited data and that it provides a relatively intuitive output. At times, when minimal information is available, capability-based analysis enables the rapid development of estimates that can be reassessed and refined once additional information is known. Since capability-based cost analysis is based on fairly simple concepts, it produces an intuitive end product that is attractive to decision makers (Hull, 2009).

One of the keys to the effective use of capability-based cost analysis is that it requires the generation of variables specific enough to meaningfully differentiate among systems and capability sets, but broad enough to be used with the limited information available at Milestone A. One of the first tasks undertaken by the team was to devote significant research and data collection time to searching for a standardized, broad set of capabilities. This capability set had to be unambiguous in language, extremely precise in description, and valid for use as a classifier or variable. Although the immediate intuition led us to the Joint Capability Areas (JCA) or Joint Integrated Activity Sets (JIAS), our efforts to conform these architectures to our particular requirements yielded little.

However, the System Capabilities Architecture (SCA), the capability variable set developed and used by ODASA-CE, leverages much from the JCA, and in fact maps directly to it with our capability-based cost analysis tool—the Capabilities Knowledge Base (CKB) (Sibert, 2009). In addition, the SCA is a fluid entity that continues to evolve based on improvement of available information and subject matter expert/peer review. As new systems are added to the CKB and knowledge of the acquired capability inventory grows, the SCA has and will continue to change.

The SCA uses plainly worded, high-level capabilities like “Move,” “Shoot,” “Communicate,” “Sense Environment,” and “Sustain” (for example), and then drills down into them. It enables the analyst to ask questions such as, Does my pre-Milestone A solution *Move*? and be able to identify an unambiguous *yes* or *no* answer. The initial framework has developed, refined, and augmented into what we believe is a suitable structure for capabilities-based parametric data analysis. This architecture is directly linked to the JCA so that department capability gaps can directly translate to capability-based analysis. However, this is certainly a living document that changes as we learn more about the department’s currently acquired and future capabilities.

When developing capability maps for systems residing within the CKB or for systems being analyzed, it is imperative to involve knowledgeable platform subject matter experts to the fullest extent possible. Although situations where analysis time is limited (and therefore collaboration time is limited) certainly arise, such situations are suboptimal. Defining a thoroughly documented system boundary is also important—in other words, clearly designate what is included and excluded from a system (or capability set). Detailed capability mapping procedures have been developed to accompany the SCA. These are necessary in order to standardize and expedite the mapping process, making it transparent and repeatable. Optimally, a CKB system user will easily be able to trace how a system was mapped to its capability set, or be able to spot any errors or anomalies quickly. Capability mapping is an iterative process subject to continuous improvement efforts by its community of interest (McCormack & Roper, 2009).

Conclusions

The department-wide efforts during recent years to enable early investment decision making have demonstrated the level of difficulty inherent in achieving such an objective. Clearly, a commitment to the fiscal responsibility and long-term acquisition stability that pre-Milestone A decision making can provide will require far-reaching culture change and a willingness to look beyond the typical issue set. Pre-Milestone A analysis is the foundation upon which investment decision making is built; understandably, a knowledge and appreciation for some of the most challenging obstacles to building this foundation is imperative. The required level of analysis and cost estimate detail must be clearly specified so that ambiguity is kept to a minimum. Additionally, the body of analysts within the department must reach a common understanding of how to define and frame capability information in order to enable capability-based analysis that is universally understood. Change is not easy, and inertia is difficult to counter; but, for early investment decisions to be successful,

the forces of friction that prevent effective pre-Milestone A analysis must be overcome.

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THE DEMISE OF THE FEDERAL GOVERNMENT SMALL BUSINESS PROGRAM

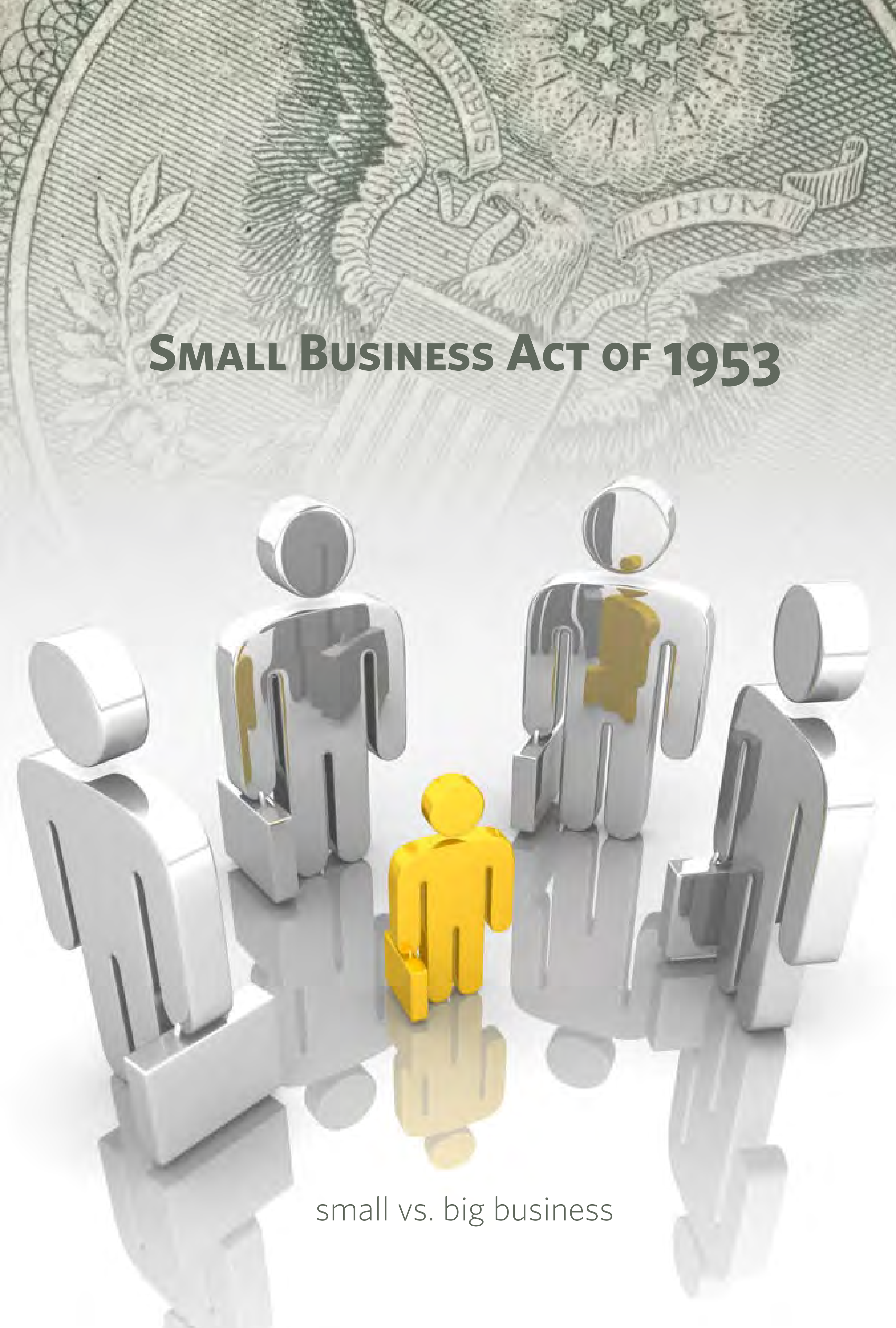
Philip G. Bail Jr.

This article examines the legislation leading up to the Small Business Act of 1953 and the resulting implementation of congressionally mandated small business goals; industry's support of small business initiatives; government oversight of small business plans; and the sometimes improper interpretation of rules and regulations affecting the Small Business Program (SBP). The combination of mandated goals, improper interpretation of regulations, and the resulting negative effect on large businesses may, as supported by the author's research, be significant factors in the program's demise. Also included are suggestions on how the federal SBP can become a viable program that benefits small businesses so they truly receive an equitable share of government dollars without infringing on supply chain initiatives of large business contractors.

Keywords: *Small Business Act of 1953, Small Business Goals, Small Business Plans, Mandated Goals, Small Business Program*

image designed by Harambee Dennis »

Small Business Act of 1953



small vs. big business

In the winter 2007 issue of the Air Force Small Business newsletter *Beyond Goals*, Scott Denniston, then director of the Office of Small and Disadvantaged Business Utilization, Department of Veterans Affairs, was asked to assess the state of the Service-Disabled Veteran-Owned Small Business Program. Denniston stated that government-wide, the 3 percent goal for awards to Service-Disabled Veteran-Owned Small Businesses had not been met. He went on to say that in past years, contracting officers had been encouraged to set aside procurements to 8(a) certified small businesses, disadvantaged small businesses, and women-owned small businesses. He could also have included HUBZone small businesses and Native American-owned businesses. Denniston (Cenkci, 2007) expressed the hope that government contracting officers would focus on veteran-owned small businesses. It is this myopic view of the federal Small Business Program, in my assessment, that will be its demise.

But how did the government arrive, or at what point in time did a government agency or its representative assume the untenable position of promoting one type of small business set-aside, while another government entity might be simultaneously promoting a different set-aside? What effect does this flavor-of-the-month attitude have on large business supply chains? Is this current interpretation of the federal Small Business Program the original intent of Congress? Does today's interpretation result in fair and reasonable prices? This article explores these issues and makes recommendations to help the federal Small Business Program survive during these uncertain times.

Background

Helping businesses in dealing with federal government contracts began in 1929 when Herbert Hoover created the Reconstruction Finance Corporation (RFC) following the Great Depression (Overview & History of the SBA, n.d.). The RFC was created to loan money to all businesses, large and small, stymied by the depression. During World War II, the prevailing view was that many small businesses could not compete with large businesses in making products and providing services in support of war efforts. As a result, in 1942 Congress created the Smaller War Plants Corporation (SWPC) (Overview & History of the SBA, n.d.). This agency provided loans to small businesses and encouraged federal agencies and large businesses to buy from such businesses. Congress also passed the Small Business Mobilization Act of 1942. This act acknowledged that a price differential might be necessary to keep small plants mobilized, but only for war efforts (Small Business Mobilization Act, 1942).

At the end of World War II, SWPC was abolished and the RFC took over its lending and contract powers. The Department of Commerce also assumed some of SWPC's responsibilities. The Department of Defense (DoD) was

pulled into the discussion of small business participation in federal contracts by the creation of the Armed Services Procurement Act of 1947. This act mandated that a fair proportion of total federal contracts should be placed with small business (Armed Services Procurement Act, 1947). The intent of this act was to continue in peacetime the policy that had prompted the enactment of the Small Business Mobilization Act of 1942.

As the Korean War began, Congress created another wartime organization to handle small business concerns—the Small Defense Plants Administration (SDPA). Its functions were similar to those of the SWPC. The SDPA certified small businesses to the RFC when it determined a business had the capability to perform the work of government contracts. At this same time, an Office of Small Business (OSB) in the Department of Commerce assumed some educational responsibilities. Believing that a lack of information and expertise was the main cause of small business failure, the OSB produced brochures and conducted management counseling for individual entrepreneurs. Congress also passed the Defense Production Act of 1950. This act again emphasized that the preservation of small business mobilization capability was necessary, even if awards were made at a higher rather than lower price (Defense Production Act, 1950).

By 1952, the RFC was no longer considered necessary, but to continue the important functions of the earlier agencies, President Dwight Eisenhower proposed creation of a new small business agency—the Small Business Administration.

In the Small Business Act of 1953, Congress created the Small Business Administration (SBA), whose function was to "aid, counsel, assist, and protect, insofar as is possible, the interests of small business concerns." The charter also stipulated that the SBA would ensure small businesses receive a "fair proportion" of government contracts.

The act stipulated that the definition of what constitutes a small business should vary from industry to industry to reflect industry differences (Small Business Act, 1953). It charged the SBA with establishing small business size standards on an industry-by-industry basis. Another stipulation of the act was that to be considered a small business concern, the concern must be independently owned and operated and not dominant in its field of operation.

Helping small businesses get a "fair proportion" of government contracts as mandated by the World War II SWPC charter and the Armed Services Procurement Act of 1947 did not lead small businesses to the government as envisioned. The Comptroller General issued a report in 1977 verifying this conclusion saying these early attempts to bring small business into the federal business environment had not been successful. A House Small Business Committee reported that small businesses, particularly those owned by the disadvantaged, had not been considered fairly as subcontractors and suppliers to prime contractors performing work for the government (Clark, Moutray, & Saade, 2006).

As a result, Public Law (Pub. L.) 95-507, a bill to amend the Small Business Act and the Small Business Investment Act of 1958, was enacted in 1978. This law (Amendment to Small Business Act and the Small Business Investment Act of 1958, 1978) created several significant changes to the federal government Small Business Program. Specifically, it—

- Made participation by large businesses in some type of Small Business Program mandatory instead of voluntary
- Changed “best efforts” to “Maximum Practicable Opportunities”
- Required a small business plan for procurements over $500,000 (now $550,000)
- Eliminated the small business “minority-owned” category
- Determined disadvantaged business concerns as being both socially *and* economically disadvantaged[1]
- Reserved solicitations under $25,000 for small business (now >$3,000 but not over $100,000)
- Required federal agencies to establish small business goals and explain to Congress when goals were not met
- Established the Office of Small and Disadvantaged Business Utilization (SADBU) (now Office of Small Business Programs in the Department of Defense).

The Small Business Act was significant because the Small Business Program now had teeth, and large business participation could be evaluated more definitively if still somewhat subjectively regarding outreach efforts. Congress also continued to refine the program by establishing separate setaside requirements and goals for additional categories of small businesses.

In Pub. L. 99-661, The Department of Defense 5% Minority Contracting Goal (1987), a 5 percent Small and Disadvantaged Business goal, and SDB setasides were implemented.[2] In Pub. L. 100-656, Business Opportunities Development Reform Act (1988), the 8(a) Program was established; a liquidated Damages Clause was added to the Federal Acquisition Regulation (FAR) to help ensure that goals were met; and 20 percent was identified as the federal agency small business prime contract goal.

In Pub. L. 103-355, the Federal Acquisition Streamlining Act (1994) was enacted. It added a Women-Owned Small Business goal of 5 percent. In 1997, the HUBZone Act, Pub. L. 105-135, was passed (Beale & Deas, 2008). It provided preferences to small business concerns located in HUBZones or areas of high unemployment. Such firms must be owned and controlled by one or more U.S. citizens, and at least 35 percent of its employees must reside in a HUBZone.

That same year the federal agency small business goal was increased from 20 percent to 23 percent.

Finally, Pub. L. 106-50, the Veterans Entrepreneurship and Small Business Development Act (1999), established goals for awards to Veteran-Owned Small Businesses and Service-Disabled Veteran-Owned Small Businesses. Those goals are now 3 percent for both Veteran-Owned and Disabled Veteran-Owned Small Businesses.

The original purpose of programs designed to help contractors do business with the federal government was to loan money to all businesses following the great depression of the late 1920s. By 1999, it had changed to a program that required federal contracting officers to reserve for small businesses all solicitations expected to exceed $3,000 but not exceeding $100,000—unless the contracting officer determined there was no reasonable expectation of obtaining offers from two or more responsible small business concerns that are competitive in terms of market prices, quality, and delivery. The FAR, in subpart 19.102, Size Standards (FAR 2005a), also required the contracting officer to set aside any acquisition expected to exceed $100,000 for small business participation only when there is a reasonable expectation that offers will be obtained from at least two responsible small businesses offering the products of different small businesses with award at fair market prices. This apparent emphasis on award at fair market prices contradicts, to some extent, the original intent of the Small Business Mobilization Act of 1942 and the Defense Production Act of 1950.

Discussion

Small businesses suddenly had many avenues to pursue in competing for government contracts, and large businesses could no longer look to small businesses solely for Bill of Materials, or BoM buildup. They now had to divide their vendor base into several more categories such as Disadvantaged Small Business, Women-Owned Small Business, HUBZone Small Business, and Veteran and Disabled Veteran-Owned Small Business. Moreover, contracting officers expected to see goals and goal achievement at the levels identified by Congress, such as 5 percent to Women-Owned Small Businesses, even if Make-or-Buy analyses for a particular solicitation did not support such goals.

These changed expectations and mandates regarding the use of small businesses appear to be overreaching when compared to the goal set forth in Pub. L. 95-507 of giving small businesses the "…maximum practical opportunity…" to compete for federal prime contract dollars and subcontract awards. However, the federal Small Business Program, if interpreted consistently using practical sound business judgment, may still be workable.

Regrettably, interpretation is often not grounded in common sense and does not follow the congressionally mandated requirements identified

in the FAR at subpart 6.1, Competition Requirements (FAR, 2005b), which states, "…with certain limited exceptions…Contracting Officers shall promote and provide for full and open competition in soliciting offers and awarding government contracts."[3] While it can be argued that providing "maximum practicable opportunities" to small business trumps the achievement of fair and reasonable prices, it is my view that contracting officers should always strive to efficiently fulfill the requirements of the warfighter at fair and reasonable prices. This is especially true today when services-type contracts are increasing in use. Unless the contracting officer is reasonably sure that a resulting contract, if set aside for small business, will be awarded at fair and reasonable prices, the solicitation should be issued as open competition, large and small.

This was echoed by John J. Young, former Under Secretary of Defense (Acquisition, Technology, & Logistics). In testimony before the Senate Committee on Armed Services on June 3, 2008, he commented on a Government Accountability Office report on weapon program outcomes (GAO, 2008a).

He identified four strategic thrust areas to make federal acquisition better. One of these thrust areas is to "Responsibly Spend Every Single Tax Dollar." Identifying complex acquisitions for small business setasides may not always ensure responsible spending of tax dollars because the best solutions to a problem may not be captured within the small business community and may prevent a business with the best technical and cost solution—a large business—from competing.

In fiscal year 2006, the DoD spent over $294 billion to procure goods and services, with more than one-third of this total to subcontractors (GAO, 2008b). Many of these subcontracted dollars were awarded to small businesses, as large businesses awarded subcontracts to small businesses as part of their small business outreach efforts; and small businesses awarded subcontracts to other small businesses in order to perform parts of awarded contracts.

With over $100 billion of federal acquisition dollars potentially going to small businesses in fiscal year 2006, a case could be made that the policies implemented to give small business a fair opportunity in the government marketplace are finally paying off. These results, while not at the congressionally mandated goals for Veteran and Disabled Veteran-Owned Small Businesses, are in line with congressional mandates to provide a maximum practical opportunity for small businesses to participate in the federal market.

However, the pressure to achieve the minimum goals in all small business categories and achieve improved year-over-year small business statistics have a sometimes negative effect on large business as the various changes to the Small Business Act and individual contracting agency interpretations of the federal Small Business Program requirements unfold.

What are some of these issues? While not all-inclusive, they can be broken down into several categories.

- Mandating specific goal achievement
- Requiring goals based on contract value, not subcontracting opportunity
- Not recognizing the negative impact of small business goals on large business supply chain decisions
- Myths
- Reorganization within the Defense Contract Management Agency
- Training shortfalls of government small business specialists and large business SBLOs (Small Business Liaison Officers).

MANDATING SPECIFIC GOAL ACHIEVEMENT

Some government solicitations now mandate the small business goals that must be achieved. The mandating of goals may violate the FAR 19.704(a)(2), Subcontracting Plan Requirements (FAR, 2005c), which only require a prospective offeror to identify total dollars planned to be subcontracted. Dollars planned to be subcontracted might differ greatly from company to company depending on in-house capability. A large hazardous waste disposal company might have fully trained employees, capable of performing all activities involved in the pickup, segregation, packaging, and transportation of hazardous waste; while another company might have to subcontract various aspects of such services. The small business plans for these two companies will be very different because the companies are very different. It is not fair to the company with in-house resources to be penalized because its small business plan is less "robust" than the company with limited resources that may have to subcontract many aspects of the services or cannot justify the agency-dictated small business goals.

The U.S. Army Corps of Engineers, New York District, issued solicitation W912DS-07-B-0011 in May 2007. This Invitation for Bid (IFB) identified various small business goals it expected bidders to meet. The IFB stated, "If plan includes goals less than indicated, explain extenuating circumstances why Corps of Engineering goals can't be met…."

The mandated small business goals in this particular solicitation ignore the likely differences in potential bidders, but more importantly, may violate the FAR in an IFB environment. FAR 14.301(a), Responsiveness of Bids (FAR, 2005d), states, "…to be considered for award a bid must comply in all material respects with the IFB. Such compliance enables bidders to stand on equal footing while maintaining integrity of the sealed bidding system." Discussions are not usually part of an IFB. The winning contractor is determined by lowest price among the responsive, responsible bidders.

Asking a bidder to explain why its small business plan does not meet the pre-determined goals of the agency contradicts the rules for advertised bids. FAR 19.702(a)(2), Statutory Requirements (FAR, 2005e), says that in sealed bidding acquisitions, the bidder selected for award must (if dollar parameters for a small business plan are met in the bid price) submit a subcontracting plan. No other requirements are identified, and no specific goal achievements are required other than best effort. If this solicitation was a request for proposal (RFP), discussion of small business plans would be more appropriate as such discussions would not broach contractor responsiveness issues to the extent they would in an IFB environment.

REQUIRING GOALS BASED ON CONTRACT VALUE, NOT SUBCONTRACTING OPPORTUNITY

Some contracting officers are requiring small business goals based on "contract value." Other agencies are requiring that all statutory goals be met before a subcontracting plan will be accepted. Both of these approaches violate the Small Business Act, Section 8(d), Subcontracting Program, which ties goals to subcontracting opportunities, not to contract value or to statutory goal minimums. Actual subcontracting opportunities, while subjective to a degree, simply may not support the meeting of statutory goals because the skill sets required in the various small business categories may not be available or the contractor may not require outside vendor/subcontractor assistance.

NOT RECOGNIZING THE NEGATIVE IMPACT OF SMALL BUSINESS GOALS ON LARGE BUSINESS SUPPLY CHAIN DECISIONS

Another reality of business today involves the efforts contractors are making to decrease the number of dollars they are spending on outsourced materials and services. Many large businesses are improving their supplier selection process by eliminating poor performers and consolidating purchases. Every time the vendor database is reduced, small businesses may suffer in the process. However, the typical large business materials department is a profit center for its company and is expected to meet certain goals associated with buying more for less. Large businesses are increasing global sourcing initiatives and maximizing economies of scale by buying more quantity from fewer suppliers. These initiatives do not usually improve the small business vendor spend statistics. However, it is not the role of the federal government to tell businesses how their supply chains should operate.

MYTHS

Myths about the Small Business Program also generate their own problems. For example, some argue that the bundling of requirements into large contracts prevents small businesses from performing on them. The SBA supports this claim and criticizes agencies that combine similar requirements to maximize economies of scale. The SBA claims 34,221 new bundled contracts were awarded between 1992 and 2001, transferring $840 billion of contract revenue from small businesses, causing a 56 percent decline in the number of small businesses contracting with the government. Yet, only 25 bid protests were filed by contractors between 1992-2004 over contract bundling—sharply contradicting the SBA's estimates of bundling frequency or negative impact to small businesses (Nerenz, 2007).

Another myth involves the idea that innovation is exclusively a small business phenomenon. Andy Grove, Co-Founder of INTEL, stated in *Portfolio Magazine* (Grove, 2007) that, "Some sectors are hobbled with intractable, industry-wide problems that only a large company can solve." He cited Apple Computer's entry into the music business and Wal-Mart's introduction of in-store health clinics as examples of solutions only possible through large business involvement.

REORGANIZATION WITHIN THE DEFENSE CONTRACT MANAGEMENT AGENCY

The Defense Contract Management Agency (DCMA) reorganized itself to align its limited resources to the more specific types of products or services it manages instead of the geographic orientation by physical location to the large businesses it monitors. This reorganization has resulted in limited face-to-face contact between DCMA small business specialists and the large business SBLOs. Elimination of the geographic proximity between DCMA and the contractors it monitors has reduced the knowledge of the government small business specialist about a specific company, and increased focus on year-over-year increases in goal accomplishment when such increases may not be possible.

TRAINING SHORTFALLS OF GOVERNMENT SMALL BUSINESS SPECIALISTS AND LARGE BUSINESS SBLOs

Training of government small business specialists and contractor Small Business Liaison Officers (SBLOs) is also lacking. Some contractor and government personnel cannot differentiate between the various types of small business plans—Comprehensive, Master, Commercial, or Individual. They are not familiar with how goals data should be calculated or how reports on goal achievement should be prepared and submitted.

Some SBLOs do not understand how to report small business dollars if a vendor fits more than one small business size category. Some agencies do not allow the use of Commercial Plans where some services—for example, dredging services—clearly meet the definition of a commercial item. This lack of knowledge is the result of the government reducing funding for its Regional Councils for Small Business Education and Advocacy and indifference of large businesses toward the Small Business Program. Many large businesses doing significant business with the federal government simply do not attend small business meetings chaired by the DoD, nor do they participate in local SBLO groups.

So what can be done to make the federal Small Business Program work better?

Recommendations

Federal agencies should re-focus the program to its original intent. If changes are not made to the program, continued compliance by large businesses may wane, and the very existence of the Small Business Program as we know it today may be in jeopardy. In the Small Business Act of 1953, Congress voiced its conviction that the federal government should, "aid, counsel, assist, and protect...the interests of small business concerns...to insure that a fair proportion of the total purchases and contracts or subcontracts for property and services for the government... be placed with small business enterprises." The federal Small Business Program can more effectively meet the intent of the Small Business Act of 1953 by making changes to the program so it truly benefits small business manufacturers and service providers, does not negatively affect the supply chain of large businesses, and helps ensure that the federal buyer gets quality products at fair and reasonable prices.

The following four recommendations, if implemented, can be the recipe for continued success necessary to energize the federal government Small Business Program.

1. Reduce employee count or revenue ceilings in North American Industry Classification System (NAICS) size standards.
2. Allow large businesses to create small business plans based on subcontracting opportunities after they conduct a comprehensive Make-or-Buy analysis for a particular solicitation.
3. Assign DCMA small business specialists the monitoring of large businesses by geographic proximity.
4. Take advantage of the expertise within Procurement Technical Assistance Centers (PTACs).

Recommendation 1. The SBA, in conjunction with the Office of Management and Budget (OMB), should re-examine how employee count or annual revenue ceilings are determined for the various NAICS codes. The goal should be to create small business size ceilings that are reflective of the size of most small businesses—500 to 1,000 employees is simply too large for the small business ceiling of most NAICS codes. The Department of Health and Human Services Web site states that 90 percent of all small businesses in the United States employ fewer than 20 employees. When a 20-person small business competes with a 1,000-person small business, it may not be a true competition between two small businesses.

Recommendation 2. First, allow large businesses to submit small business plans based on their internal capabilities and documented determination regarding outsourcing. When preparing the RFP, do not include small business plan goals in the Section M, Evaluation Factors for Award criteria. Subcontracting opportunities may be very different from one large business to another. Because a large business identifies higher small business goals does not make that plan better than another large business that identifies smaller goals. Plans may be very different from large business to large business, but still represent maximum practicable opportunity for small businesses to participate in contract performance consistent with the management plan of the large business. By including small business plan goals as a criterion, one increases—needlessly, in my view—the complexity of the evaluation and the possibility of botching the source selection. Grading one small business plan "better" than another without taking into consideration the makeup and business model of the large business could also lead to protests after award (GAO, 2007) and jeopardize timely support of the warfighter.

Second, do not dictate small business goals in solicitations. Dictating goals does not acknowledge that goal identification is the responsibility of each large business based on its subcontracting opportunities.

Third, if goals do not meet the Congressional goal mandates for various categories of small business, so be it. Large businesses should not be forced to meet congressionally mandated goals if the subcontracting opportunities do not warrant such goals.

Large business SBLOs have a multi-faceted job description, differing in some ways from company to company. However, if the large business SBLOs are doing their job effectively, they should be making sure company employees—especially purchasing department buyers—fully understand the government Small Business Program and the associated buyer responsibilities to provide maximum practicable opportunity for small businesses to compete for subcontracting requirements. SBLOs should also keep abreast of changing Small Business Program requirements, whether they involve a change in mandated goals or a change in reporting, such as a transition from paper reports to electronic reports.

In years past, the large business SBLOs kept abreast of changing requirements by attending quarterly or semiannual meetings with other large businesses in their immediate geographic area as part of a large business SBLO group. Such groups usually included participation by a small business specialist from the DCMA. It was this interface between large business SBLOs and DCMA small business specialists that kept all parties informed about the Small Business Program. The DCMA reorganized its small business specialists in 2005. This reorganization eliminated geographic proximity of the DCMA small business specialists and the large businesses they monitored, resulting in less communication and less face-to-face interface.

Recommendation 3. Re-orient DCMA small business specialists so they are in geographic proximity to the large businesses they monitor. This re-orientation will result in better oversight of large business compliance with the intent of the Small Business Program.

Many agencies and associations—some funded by the federal government, some funded by state governments—promote small businesses selling to the federal government. A myriad of companies is also focused on some part of the small business market. These organizations include the National Association of Minority Contractors (NAMC), National Association of Women Business Owners (NAWBO), the Office of Women's Business Ownership (OWBO), The Center for Veterans Enterprise (VetBiz), the National Veteran-Owned Business Association (NaVOBA), Minority Business Development Agency (MBDA), and the Latin Business Association (LBA) to name a few. The problem with all of these organizations is their inherent focus on their own particular category of small business

Yet, one organization, Procurement Technical Assistance Centers (PTACs), stands out from the rest because PTACs look at the bigger picture instead of the flavor-of-the-month mindset that places emphasis with women-owned firms today, but with veteran-owned firms tomorrow. PTACs, to the contrary, work effectively with all small businesses, regardless of the small business type, in helping them make contact with large businesses or federal buying agencies.

Authorized in 1985 by Congress, the Procurement Technical Assistance Program (PTAP) strives to increase the number of proficient businesses engaging in the government marketplace. PTACs often reflect the communities and areas in which they serve, so they vary in size and shape. A small percentage of PTACs are administered by state governments, while others work in partnership with community colleges, universities, local economic development corporations, or other institutions in the local area.

Recommendation 4. Emphasize to large businesses, small businesses, and federal buyers that PTACs should be the focal point for small business

vendor outreach. Emphasize to small businesses that PTACs are the best resource for information on doing business with the federal government. De-emphasize any focus on "one trick pony" associations and agencies so the federal Small Business Program is more in line with the original intent of the Small Business Act of 1953—to help small businesses.

Conclusions

If the federal Small Business Program is enforced from the perspective of its original intent, goal achievement for the sake of goal achievement will be de-emphasized, and the recommendations identified in this treatise will be seriously considered. If these steps are taken, small businesses should continue to prosper in the federal marketplace and receive a fair proportion of government contracts. Additionally, the American taxpayer will see better use of taxpayer dollars. These actions, if enforced, will mark a return to the original objectives of the Small Business Act of 1953.

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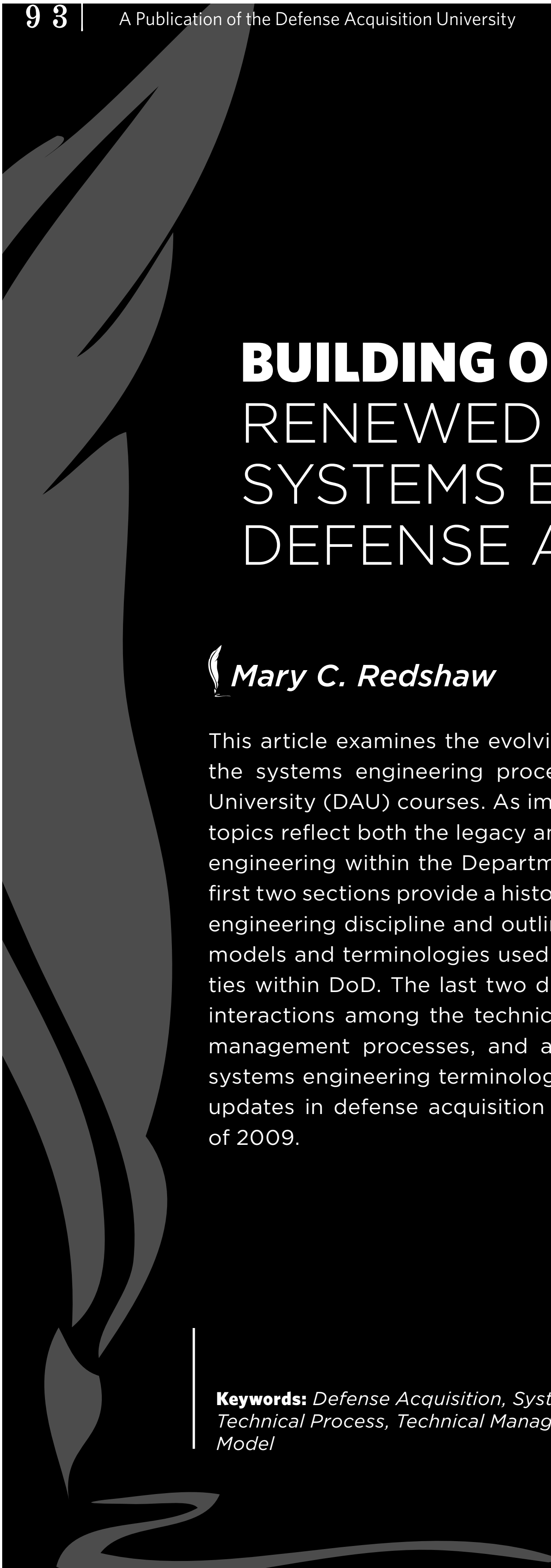
ENDNOTES

1. Prior to Pub. L. 95-507, minority businesses were defined as socially ***or*** economically disadvantaged small businesses. According to a Congressional Report at the time, the change from "or" to "and" was to prevent the increasing number of "front" companies—companies posing as minority businesses but controlled by non-minorities.
2. This setaside was rescinded in 1996.
3. FAR 6.202, Establishing or Maintaining Alternative Sources, establishes or maintains an alternative source if agency head determines doing this will also result in reduced overall costs; or is in the interest of national defense; or ensures continuous availability of a reliable source; or fulfills a statutory requirement related to small business concerns; or only one source will satisfy agency requirements.



BUILDING ON A LEGACY: RENEWED FOCUS ON SYSTEMS ENGINEERING IN DEFENSE ACQUISITION

Mary C. Redshaw

This article examines the evolving model used to describe the systems engineering process in Defense Acquisition University (DAU) courses. As implied in the title, discussion topics reflect both the legacy and current focus of systems engineering within the Department of Defense (DoD). The first two sections provide a historical context of the systems engineering discipline and outline the evolution of process models and terminologies used to describe process activities within DoD. The last two discussion sections describe interactions among the technical processes and technical management processes, and analyze the implications of systems engineering terminology changes introduced with updates in defense acquisition guidance released in June of 2009.

Keywords: *Defense Acquisition, Systems Engineering, Technical Process, Technical Management, Process Model*

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In 2004, Department of Defense (DoD) officials initiated efforts to revitalize systems engineering practices in defense acquisition programs. Acting in his role as the Defense Acquisition Executive, Michael Wynne (2004) issued a policy memorandum that stressed the need "to drive good systems engineering practices back into the way we do business" (p. 2). That statement highlighted an assessment that revitalization efforts would build on a legacy of proven processes and practices first formalized to support defense acquisition programs in the past. Terminologies and models describing the systems engineering process continue to evolve. However, fundamental aspects of the discipline have not changed since DoD released the first systems engineering standard (DoD, 1969).

The continuing need for systems engineering is driven by the increasing technical complexity and development costs of defense acquisition programs. Programs developing complex systems exhibit the same features that led to the need to formalize the systems engineering process in the first place, as noted in an early text published by the Defense Systems Management College (DSMC, 1986). Many acquisition programs involve large, geographically dispersed design teams, numerous subsystems under concurrent development, severely constrained development time, and incorporation of advanced technologies.

Purpose

This article examines the evolving systems engineering process model taught as part of Defense Acquisition University (DAU) courses. One can gain new perspectives on systems engineering process interactions by tracing the model's evolution over time. This article will provide a historical context of the systems engineering discipline in DoD, outline the evolution of process models and terminologies used in DSMC and DAU courses, and analyze the implications of terminology changes introduced in the *Interim Defense Acquisition Guidebook* (Interim DAG) released by the Office of the Secretary of Defense (OSD) in 2009.

Historical Context

According to the International Council on Systems Engineering (INCOSE, n.d.), the term *systems engineering* was first used at Bell Telephone Laboratories in the early 1940s. Interest in the systems engineering discipline grew during World War II when project managers and engineers oversaw the development of capital ships, aircraft, and weapons systems (National Research Council, 2008). Use of systems engineering practices increased following World War II as government programs leveraged an array of new technologies in developing computer

systems, command and control centers, telecommunications, ballistic missiles, missile defense systems, and spacecraft. The coordination of development teams employing thousands of engineers integrating multiple subsystems drove the need to formalize the methods for delivering useful, reliable systems (DSMC, 1986; National Research Council, 2008).

FORMALIZING THE DISCIPLINE

Because of the department's role in acquiring and developing large-scale, complex systems, defense acquisition managers led the way in codifying the systems engineering process—beginning with the publication of Military Standard 499 (MIL-STD-499). The baseline version of MIL-STD-499 was approved for trial use by U.S. Air Force developmental agencies and "for possible conversion to a fully coordinated document mandatory for use by all Department of Defense Agencies" (DoD, 1969, cover). The baseline MIL-STD-499 documented the first formal consensus standard governing the systems engineering community of practice. Department officials approved a subsequent revision of the military standard (MIL-STD-499A) for Air Force use only (DoD, 1974). However, MIL-STD-499A quickly became the de facto systems engineering standard for many defense acquisition programs.

During the early 1990s, DoD's systems engineering standard underwent another review cycle. Two parallel (but opposing) actions impacted what was then the only documented standard for systems engineering. Both actions unfolded under the banners of defense acquisition reform.

THE LOSS OF A STANDARD

The Air Force Materiel Command sponsored a joint working group comprised of representatives from OSD, the Services, and industry organizations. The working group formed to review and revise MIL-STD-499A for use by all DoD components, federal agencies, and commercial organizations. Members of the joint committee actively solicited inputs from a wide array of organizations and circulated a coordination draft of the revised standard (MIL STD 499B) to reviewers in government, industry, and academia in 1992. The foreword of the final coordination draft of MIL-STD-499B (DoD, 1994) outlined the focus of the revised standard. The purpose of the new standard was to define a comprehensive, executable process that would result in optimal system solutions while meeting cost, schedule, and performance objectives. According to its drafters, the standard process would be applicable in all phases of system development and could be tailored to the size and complexity of any effort. The drafters also claimed that the revised standard would achieve key DoD acquisition reform efforts to encourage innovation in products and practices; to

better integrate requirements through multi-disciplinary teamwork; to increase teamwork and cooperation within the government and industry; and to reduce the time needed to acquire products and services (DoD, 1994). Stakeholders who participated in the development and review of MIL-STD-499B hailed the document as a true consensus standard.

However, the revised standard was never approved by DoD officials due to another acquisition reform initiative that emphasized use of commercial standards over government standards. Defense Secretary William Perry (1994) issued a policy memorandum barring the use of military specifications and standards on DoD acquisition programs. Exceptions to the new policy required a written waiver from the program's milestone decision authority. As a result, the final draft of MIL-STD-499B was never approved for DoD use, and MIL-STD-499A was cancelled without replacement in 1995.

A PROLIFERATION OF STANDARDS

Because no commercial systems engineering standards existed, two U.S. standards bodies used MIL-STD-499B as the starting point for developing and releasing their own standards in 1994. The Electronic Industries Association (EIA, 1994) issued an interim standard (EIA/IS-632) developed by a working group of participants from industry associations, INCOSE, and DoD. The new standard outlined a consensus process intended for use by commercial enterprises, government agencies, and defense contractors. Similarly, the Institute of Electrical and Electronics Engineers (IEEE, 1994) released a systems engineering standard (IEEE 1220-1994) for trial use by industry organizations. In turn, these standards underwent subsequent diverging revisions that formed the basis for a proliferation of organizational process guides. Arguably, and as a direct result of Perry's (1994) memorandum barring use of military standards, the practice of systems engineering (and the related field of software engineering) became increasingly fragmented within DoD and across departments and agencies due to the use of proliferating industry standards, process improvement frameworks, and organization-specific guides and handbooks. The organization that first codified the discipline now found itself without a standard governing its systems engineering practices.

DoD'S STANDARDIZED TERMINOLOGY

Subsequent to the 2003 release of major revisions to policy documents governing defense acquisition management, OSD (2004) released the first (baseline) version of the *Defense Acquisition Guidebook* (DAG). The DAG outlined discretionary best practices for the acquisition workforce—including a chapter devoted to systems engineering. Overtly recognizing

that “many systems and software engineering process models and standards use different terms to describe the processes, activities, and tasks within the systems engineering and other life cycle processes” (OSD, 2004, ¶ 4.2.2.2), the DAG outlined eight *technical management processes* and eight *technical processes* to be applied throughout the life cycle of DoD acquisition programs.

Presumably in an attempt not to endorse or specify a particular industry standard, the authors of the baseline DAG chose not to represent the 16 generic systems engineering processes in a model. Instead, the DAG described typical phase-specific activities, with a different graphical depiction accompanying the descriptions for each phase of the life cycle. The same phase-specific graphical depictions also appeared in the *technical* portion of the 2004 (and subsequent) versions of the *Integrated Defense Acquisition, Technology, and Logistics Life Cycle Management Framework*—commonly referred to as the *Wall Chart* (DAU, 2004). The technical portion of the *Wall Chart* included activities related to systems engineering, test and evaluation, and supportability—with no correlation to the 16 systems engineering processes described in the DAG.

Following a 2008 revision to DoD Instruction 5000.02 governing the *Operation of the Defense Acquisition System* (DoD, 2008), the revised Interim DAG (OSD, 2009) was posted to DAU’s Acquisition Community Connection Web site the following year. The number of generic systems engineering processes described in the new Interim DAG remained the same: eight technical management processes and eight technical processes. However, three of the technical process names changed—indicating that DoD’s “standardized process terminology” (OSD, 2009, ¶ 4.2.3) had evolved in alignment with revisions to the international standard issued jointly by the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC 15288:2008).

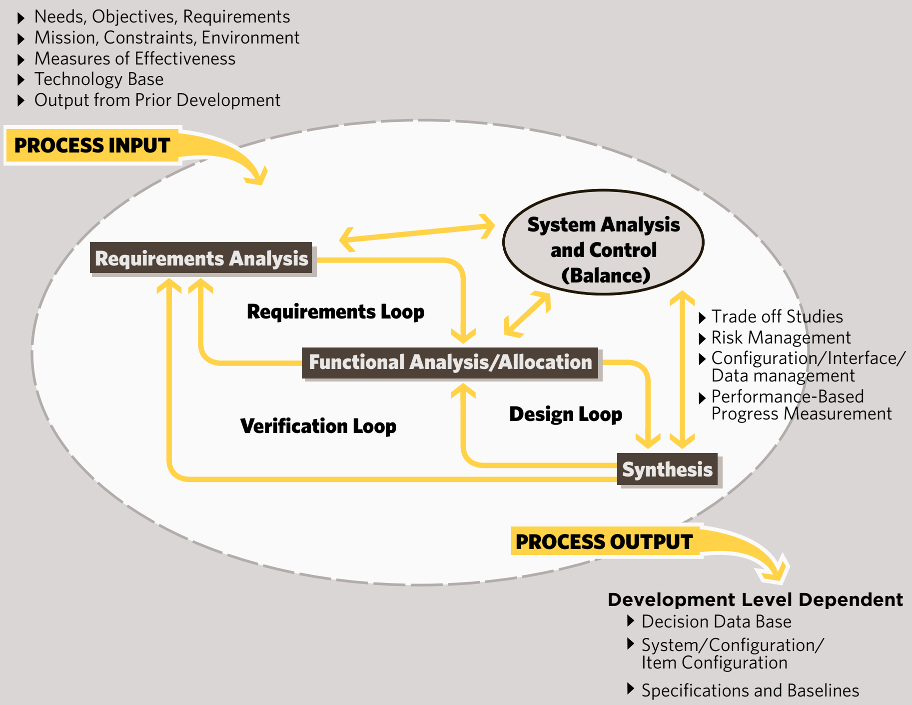
An Evolving Systems Engineering Process Model for DoD

Instructors at DSMC (and later at DAU) had used variations of the MIL-STD-499 systems engineering process model to teach systems engineering principles and practices to members of the acquisition workforce since 1974 (Schmidt & Crisp, 2006). The university’s courses still included the legacy systems engineering process model when OSD officials released the baseline DAG in 2004. The model used by DAU faculty members to support discussion of the systems engineering process evolved in recent years with changes introduced in the baseline DAG (OSD, 2004) and subsequent updates in the Interim DAG (OSD, 2009).

LEGACY MODEL

A depiction of the legacy systems engineering process model appears in Figure 1. The legacy model has several advantages. One advantage is an elegant simplicity that lends itself to describing—and understanding—essential elements of the systems engineering process. That simplicity facilitated instruction and learning while conveying some of the complexities of the systems engineering problem-solving methodology. The legacy model depicts three primary, sequential design process steps: *requirements analysis, functional analysis and allocation, and synthesis.* Additionally, the model portrays an oval shape entitled *systems analysis and control* that represents technical management activities and tools that support all three primary design process steps. At a high level, the model captures the top-down application of the design steps, their interfaces with technical management activities, and iterative, recursive loops between process pairs that ensure all system requirements are completely defined, traced, and verified.

FIGURE 1. LEGACY (MIL-STD-499B) PROCESS MODEL



However, the legacy model also has disadvantages. One disadvantage is the failure to elaborate the *systems analysis and control* portion of the model. Another disadvantage is that the *verification loop* does not highlight the importance of test planning, testing, and evaluation of results as integral parts of the product development process. Perhaps the latter

disadvantage is one of the reasons why variations of V-shaped models that explicitly show test-related activities have become prevalent depictions of the systems engineering process. The "V" form (or *Vee*) "most accurately represents system evolution from the perspective of decomposition and integration activities" (Forsberg, Mooz, & Cotterman, 2005, p. 109). Of particular note, the first international systems engineering standard (ISO/IEC 15288:2002) employed a V-shaped process model.

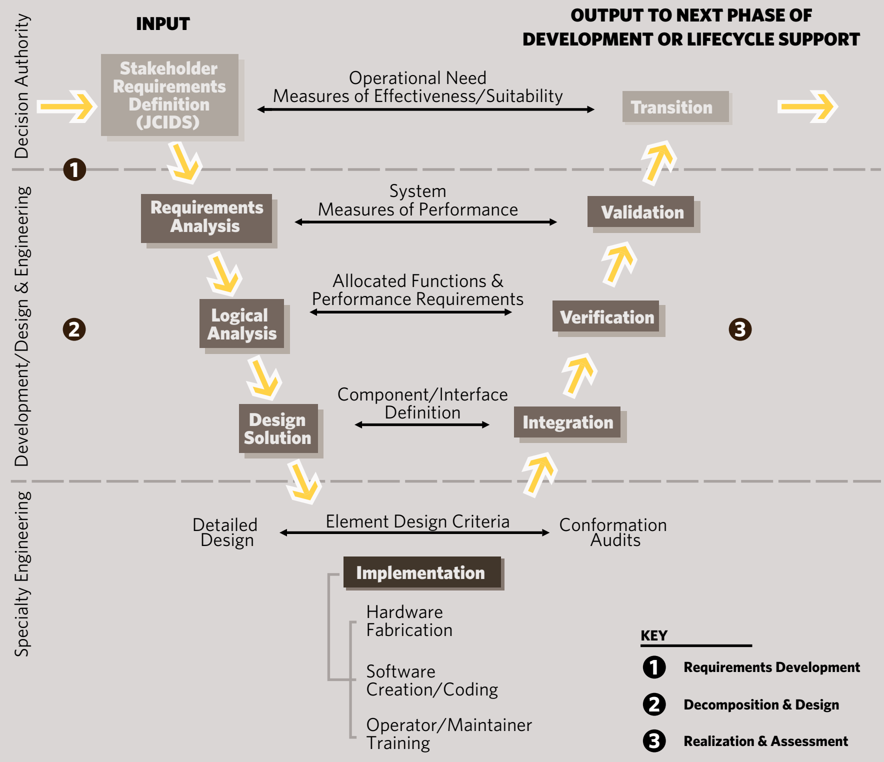
With the introduction of the new process terminologies in the baseline DAG and a revised *Wall Chart* in 2004, instructors teaching systems engineering principles in DAU courses faced a quandary. Lesson materials contained the legacy systems engineering model, but that model did not match the descriptions of the standardized technical management processes and technical processes endorsed by OSD or the depictions of the phase-specific technical activities in the DAG and the *Wall Chart*. Under normal circumstances, the courses in DAU's career field curricula are updated to reflect changes in policy as soon as possible after those changes occur. In this case, however, course developers at DAU planned extensive changes to selected courses as part of a *systems engineering revitalization* initiative sponsored by the Systems and Software Engineering Directorate within OSD. The Defense Acquisition Executive (Wynne, 2004) challenged educational leaders at DAU to "reinvigorate" (p. 2) systems engineering training. In response, the university's administrators initiated a complete makeover of the systems engineering curriculum.

As part of the effort to revise the *Systems Planning, Research, Development, and Engineering* (SPRDE) curriculum, one of DAU's course managers submitted a white paper (Redshaw, 2004) to the SPRDE performance learning director at the university's headquarters. Redshaw's white paper outlined a proposed unified approach to developing the replacement for the course that she managed. The white paper included descriptions and graphics of two models Redshaw proposed to use in the new course to portray the eight *technical processes* and eight *technical management processes* described in the DAG.

THE HIERARCHICAL VEE MODEL

One of the models in Redshaw's white paper (2004) appears in Figure 2. The model portrays the technical management processes in a V-shaped pattern (or *Vee*) superimposed on a notional organizational hierarchy. The Vee shape was adapted from the international systems engineering standard (ISO/IEC, 2002). The organizational hierarchy was adapted from a framework developed by Kossiakoff and Sweet (2003). The white paper explicitly correlated the left-hand and right-hand activities in the Vee to the three primary processes and the verification loop in the legacy process model. The left-hand side of the Vee captured the top-down design process; the right-hand side reflected the design *implementation,*

FIGURE 2. HIERARCHICAL VEE MODEL



integration, verification, validation, and *transition* activities described in the DAG. Redshaw's hierarchical depiction of the systems engineering technical processes was included in subsequent updates of the *DAU Program Managers Tool Kit*, with the graphic's last appearance in the 14th edition (DAU, 2008).

The hierarchical Vee depiction provides a powerful visualization of interfaces among key stakeholders and domains of responsibility in the acquisition process as well as "process linkages" (DAU, 2008, p. 78) between the steps on the left-hand and right-hand sides of the Vee. The top portion highlights process and organizational interfaces between decision authorities and the project team developing the system. Depending on the project or the area of the system hierarchy under consideration, the primary stakeholders may include the users, project sponsors, senior decision makers, project or engineering managers at a higher level in the system hierarchy, or the acquiring organization in an acquirer-supplier contract agreement.

The first technical process described in the baseline DAG (OSD, 2004) was *requirements development*. At the system level, Redshaw's (2004,

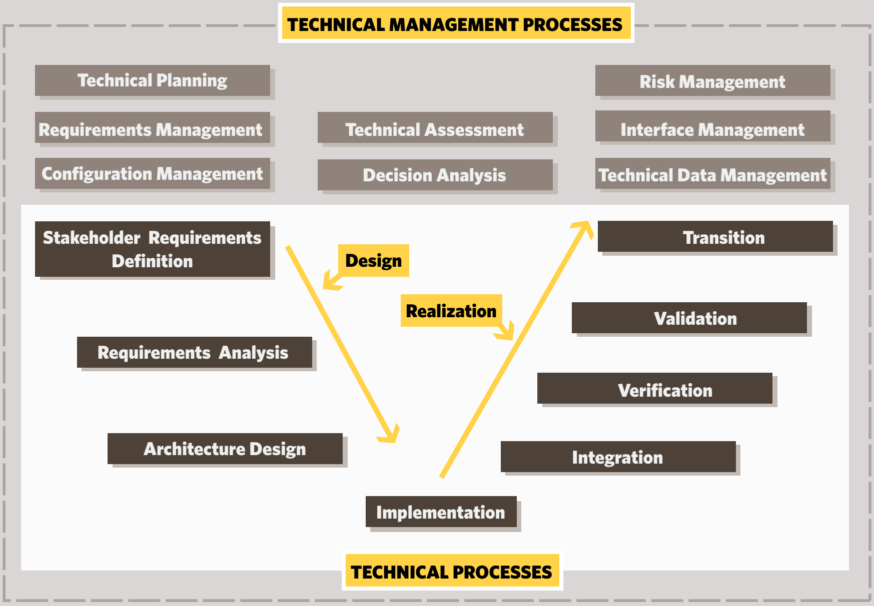
2006) hierarchical Vee model portrayed requirements development as two subordinate processes occurring at the organizational intersection of the project's development team with the Acquisition Management System and the Joint Capabilities Integration and Development System (JCIDS).

The outputs of the first subordinate process—*stakeholder requirements definition*—include the capabilities documents that govern technology development, system development, and production as well as baseline agreements between decision authorities and the development team that establish project scope and deliverables. The concept of organizational interfaces is particularly important in a system-of-systems or net-centric context. The systems engineer responsible for developing a system or subsystem must view it *from the outside*, or within the framework of the larger architecture in which the system is intended to operate. "To achieve good results, systems engineers involve themselves in nearly every aspect of a project, pay close attention to interfaces where two or more systems or system elements work together, and establish an interaction network with stakeholders and other organizational units of the enterprise" (Haskins, Forsberg, & Krueger, 2007, p. 41). In addition to the interface between the JCIDS and acquisition domains, translating users' needs into technical requirements involves interfaces between the acquiring agency and the supplier's organization, and between the systems engineer and other engineering managers at various levels in the system hierarchy.

The second subordinate process is *requirements analysis*—a direct and deliberate correlation to the first process step in the legacy systems engineering process model. Anyone familiar with the legacy model readily can see the correlation of its remaining two design process steps (*functional analysis & allocation* and *synthesis*) with two technical processes described in the baseline DAG (*logical analysis* and *design solution*, respectively).

The component level of design occurs at the interface of the systems engineering and specialty engineering domains in the system hierarchy. As the detailed design is finalized for *implementation*, the systems engineer and component design specialists identify and resolve technical issues and select workable, producible solutions that will not jeopardize the overall system design, capabilities, performance, or suitability (Kossiakoff & Sweet, 2003). Implementation of system elements occurs within specialty domains (Schmidt & Crisp, 2006). However, the systems engineer monitors the outcomes because they affect the overall design, performance, cost, and schedule. Similarly, the systems engineer monitors the outcomes of integration, verification, and validation with an eye to potential discrepancies requiring design modifications. At the end of each development phase, project managers and decision authorities review systems engineering outputs during the *transition* process to determine if results warrant further development, production, or deployment to operational use.

FIGURE 3. UPDATED CSEP MODEL



A COMPREHENSIVE SYSTEMS ENGINEERING PROCESS (CSEP) MODEL

Redshaw's white paper (2004) also proposed a *comprehensive systems engineering process* (CSEP) model. The CSEP model depicted the eight *technical processes* operating within a framework governed by the eight *technical management processes*. The author refined the CSEP framework over time, culminating in an article that proposed it as a new model for DoD systems engineering (Redshaw, 2006). Faculty members across DAU adopted variations of the CSEP model as a visual aid to explaining the systems engineering process to practitioners in various acquisition career fields. An updated CSEP model appears in Figure 3.

Process Interactions

The updated CSEP model in Figure 3 incorporates the standardized terminology in the Interim DAG that OSD released in 2009. The latest revision (as this article goes to press) of the *Program Managers Tool Kit* (DAU, 2009) included a similar depiction of the comprehensive systems engineering process. While terminologies and process depictions have evolved over time, the process interactions depicted in the CSEP model have remained essentially the same as those implied in the legacy systems engineering model.

TECHNICAL PROCESS INTERACTIONS

Members of the development team apply the *technical processes* at all stages of development to elaborate the system, generate information for decision makers, and provide starting points or inputs for the next level of development. The technical processes are used to (a) develop and define the requirements for the system and lower-level configuration items; (b) transform requirements into technical product, process, and material descriptions; (c) fabricate system elements; (d) assemble system elements into higher-level assemblies and end products; and (e) verify and validate system products, capabilities, and services against requirements established at each level in the system hierarchy.

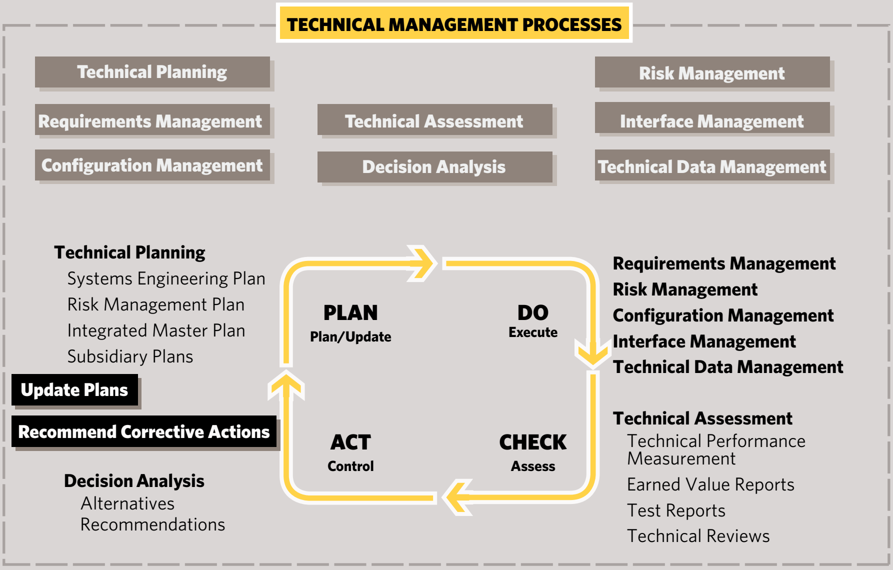
The V-shaped model highlights some of the important characteristics of the technical processes, including the sequential order of process completion. The left-hand side of the Vee portrays the top-down design that occurs as requirements are allocated progressively from the system level to lower-level elements in the architecture in a manner consistent with the arrangement of the design process steps in the legacy model. However, the V-shaped model explicitly illustrates the bottom-up design implementation from lowest level components to higher assemblies in order to integrate the complete system, verify and validate that all requirements are met, and transition to the next level of the system structure or to the next life cycle phase.

In addition to their application across the life cycle, the technical processes are applied at different levels in the system hierarchy to elaborate and mature the system. In the top-down application on the left-hand side, measurable criteria are documented at each level of system decomposition and design—forming the basis for test and evaluation during bottom-up system realization on the right-hand side. Using an automotive analogy, the technical processes form a problem-solving *V-8 engine* that is applied throughout the life cycle to ensure complete and balanced coverage of input and derived requirements to lower elements in the system hierarchy. At the end of each development phase, project members review outputs and evaluate test results to determine if all products meet requirements. Decision makers determine if acquirer-supplier agreements are met, if further system development and maturation is warranted, and if the project is ready to *transition* to the next planned effort, phase, or acquisition life cycle function (such as production, deployment, or operation).

TECHNICAL MANAGEMENT PROCESS INTERACTIONS

The *technical management* processes in the CSEP model are equivalent to the *systems analysis and control* portion of the legacy model. Members of the development team apply the technical management processes to establish and evolve project plans, assess actual achievements and

FIGURE 4. OPERATION OF THE TECHNICAL MANAGEMENT PROCESSES

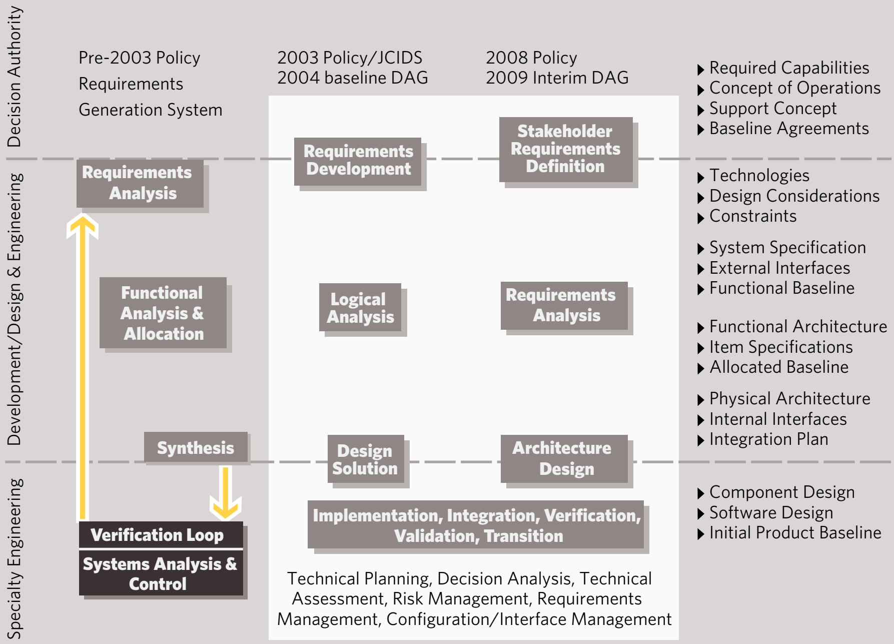


Technical Management Processes are used to manage the technical development of the system, including its supporting or enabling products. They include: Technical Planning, Technical Assessment and Decision Analysis, and a set of processes collectively referred to as Technical Control Processes. These include: Requirements Management, Interface Management, Risk Management, Configuration Management, and Technical Data Management.

progress against those plans, evaluate and select alternatives, and control project execution. Note that in the CSEP model the technical processes always operate within the encompassing framework of the technical management processes. While the technical management processes follow no explicit order, they typically interoperate cyclically as shown in Figure 4. The results of one part of the cycle become the inputs to others.

Collectively, the technical management processes form the executive—or *control logic*—that steers system development to meet project or phase objectives. Using another automotive analogy, the technical management processes operate together as a *rotary engine*. These processes operate continuously in concert with one another to support and control the application of the technical processes, balance technical and business needs of all stakeholders, implement project plans, and respond to unforeseen events. Documented technical project plans form the basis for execution and assessment. Team members continuously assess results to determine progress in meeting project plans and to identify the need for corrective actions or additional planning.

FIGURE 5. EVOLVING TERMINOLOGIES REFLECT EXPANDED FOCUS



New terminologies for an expanded focus. Recall that the baseline DAG (OSD, 2004) introduced eight technical processes and eight technical management processes. Redshaw (2004, 2006) correlated the legacy systems engineering process model to the new terminologies in the DAG through the hierarchical Vee, depicting the technical processes and a comprehensive model that included all 16 processes. Redshaw argued that the three design processes applied by the development project team were the same in both models, although terminologies had changed slightly to reflect that actions associated with the JCIDS process provided inputs to govern system development. Figure 5 shows the evolution in terminologies from the legacy MIL STD 499 systems engineering model (prior to 2003), the baseline DAG (OSD, 2004), and the Interim DAG (OSD, 2009).

Figure 5 also overlays the concept of hierarchical domain responsibilities with notional considerations and outcomes in all three models. Visually, the progression in Figure 5 suggests a key concept about the role of systems engineering in balancing the tension between requirements and the evolving design. "Systems engineering serves as the glue that binds the technical solution to the high-level requirements and maintains the program baseline" (Meier, 2008, p. 67). To achieve successful acquisition outcomes, stakeholders in all domains of responsibility must practice disciplined systems engineering.

By categorizing two sets of processes, the drafters of the baseline DAG (OSD, 2004) and the Interim DAG (OSD, 2009) emphasized

another instructional point. Systems engineering is both a technical and a management discipline, and acquisition practitioners must apply both sets of processes in tandem throughout the system life cycle (DSMC, 1986). Solid technical planning is the starting point to determine how the project team will apply the systems engineering processes in a coordinated fashion in each phase of development. Current acquisition policy prescribes that program managers embed systems engineering in program planning (DoD, 2008).

The legacy model emphasized the importance of three design processes that—despite the changes in terminology—appear among the new technical processes. These three steps are the heart of the technical aspect of systems engineering as "the translation of a user's needs into a definition of the system and its architecture through an iterative process that results in an effective design" (National Research Council, 2008, p. 1). Due diligence in applying these first three process steps assures a robust design with sufficient flexibility and adaptability to facilitate successful completion of the remaining steps and the project (Meredith & Mantel, 2000). In applying the design steps, stakeholders explicitly identify relationships, requirements interdependencies, and assessment criteria tracked throughout system development (Meade & Farrington, 2008). When applied in a disciplined manner in conjunction with the technical management processes, the design steps lay the groundwork for a solid technical solution.

Using the updated terminology in the Interim DAG (OSD, 2009), *stakeholder requirements definition* establishes a firm baseline for system requirements and constraints the development project team must meet, thus defining project scope. During *requirements analysis*, members of the project team examine users' needs against available technologies, design considerations, and external interfaces to begin translating operational requirements into technical specifications. *Architecture design* entails developing a coherent functional architecture to achieve required capabilities across scenarios from the operational concept; developing a physical architecture, internal interfaces, and integration plan; synthesizing alternative combinations of system components; and selecting the optimal design that satisfies and balances all requirements and constraints. The optimal design is one that results in a validated, affordable system that is operationally effective and suitable.

Summary

The legacy model formerly used in DSMC and DAU courses traces its genealogy to MIL-STD-499 (DoD, 1969, 1974, 1994), which was the first—and for 26 years the only—documented consensus standard for the systems engineering discipline. While retaining essentially the same design process

steps and attributes of the legacy systems engineering process model in Figure 1, the hierarchical Vee and CSEP models offer additional valuable insight. The hierarchical model in Figure 2 illustrates interactions among domains of responsibility and relationships among the eight technical processes. The CSEP model in Figure 3 connotes the encompassing and executive nature of the eight technical management processes described in the baseline DAG (OSD, 2004) and the superseding Interim DAG (OSD, 2009). The V-shaped pattern of the technical processes in Figure 2 and Figure 3 illustrates a sequential order of application to achieve top-down design and bottom-up realization of the system. The rotary pattern in Figure 4 depicts a continuing cyclical interaction among the technical management processes. The technical management processes provide the *executive logic* that governs and controls the technical problem-solving methodology in the *V-8 engine*.

The introduction of new process steps in the baseline DAG (OSD, 2004) and the updated Interim DAG (OSD, 2009) highlight the interaction of systems engineering in all aspects of development, while the categorization of two sets of processes emphasizes that systems engineering is both a technical and a management discipline. Figure 5 summarizes the evolution of the terminologies used to denote key design steps in the systems engineering process. Building on the legacy of the standard that first formalized the discipline in 1969, the evolution in terminologies and process models supports the increased emphasis on systems engineering throughout the life cycle and in all domains of responsibility. As emphasized in current defense acquisition policy, achieving successful program outcomes requires effective acquisition management that reflects a disciplined approach to systems engineering.

Author Biography

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OPEN SYSTEMS: DESIGNING AND DEVELOPING OUR OPERATIONAL INTEROPERABILITY

MAJ James Ash, USA (Ret.) and LTC Willie J. McFadden II, USA (Ret.)

The need for technological innovation in the U.S. Army is continually increasing. The challenge is to institute a "change paradigm" that will allow the incorporation of new technology into existing systems to address current and future challenges, within fiscal and technological constraints. Open Systems is such an approach. An Open Systems environment facilitates a more efficient assimilation of technology. Furthermore, Open Systems would reduce the costs of technology integration and encourage efforts toward integrated training and operational readiness, using standards and protocols across our nation's warfighting enterprise. Various goals and challenges are inherent to the use of an Open Systems approach, such as Transformation Life Cycle, interoperability, physical connectivity, and political and technical solutions, which are described herein.

Keywords: *Open Systems, Open Architecture, Architecture, System, System of Systems, Transformation Life Cycle*

image designed by Derrick Powell »


OPERATIONAL
INTEROPERABILITY
U.S.ARMY
DEVELOPING
DESIGNING

A Challenged Environment

The U.S. Army is smaller today than it has been in years past, yet it takes on ever-increasing demands for its services. Furthermore, as the Army's operational tempo increases, associated increases in procurement and sustainment costs inevitably escalate. As a result, warfighter training, warfighter planning, and real-time warfighting must be conducted in a more seamless and integrated fashion.

Due to the ever-changing nature of warfare and its accompanying operational demands, the need for technological innovation is continually increasing. The challenge is to institute a "change paradigm"—a new perspective that will allow the incorporation of new technology (unmanned systems, intelligent agents, cyber assets, space systems), within the boundaries of current fiscal and technological constraints—into existing systems to address or resolve many of the challenges discussed here and more.

The Open Systems Approach

A real and possible solution to incorporate new technologies into current systems is for the Army to intensify its efforts to achieve an Open Systems environment. An Open Systems (also known as Open Architecture) environment would facilitate a faster and smoother assimilation of technology. Furthermore, Open Systems would also reduce the costs of technology integration and would encourage efforts toward integrated training and operational readiness, using standards and protocols across our nation's warfighting enterprise. The flexibility of integrating our systems, via open architectures, is a critical component to our Army's force modernization.

The idea of implementing an Open Systems approach already has the support of the Department of Defense (DoD). The Office of the Secretary of Defense established the Open Systems Joint Task Force (OSJTF) in the mid-1990s, and its charter clearly focused all Services on the future of a Modular Open Systems Approach.

Understanding Open Systems theory and how it relates to enhancing warfighting efforts is an important responsibility that is shared between DoD and corporate partners. Before beginning the development of specific solutions through the OSJTF, it is imperative that the goals and strategies be in place. This is a challenging issue due to the number of stakeholders involved in an Army Open Systems approach (Table 1).

TABLE 1. OPEN SYSTEMS ARCHITECTURE–ARMY SIGNIFICANT STAKEHOLDERS

1.	OSJTF
2.	Army G-8, Army G-3, Army G-6, Headquarters, Department of the Army
3.	Army Materiel Command (AMC)
4.	Training and Doctrine Command (TRADOC)
5.	Weapon System Technical Architecture Working Group
6.	U.S. Army Research, Development, and Engineering Command
7.	SEI Carnegie Mellon
8.	Original Equipment Manufacturers (i.e., Boeing, General Dynamics, Raytheon, Sikorsky, etc.)

CHARACTERISTICS OF OPEN SYSTEMS

Open Systems theory is a comprehensive model that describes the elements of an organization and their dynamic interrelationships (Hanna, 1988). It states that organizations are an arrangement of elements that have interdependence on one another.

William Pasmore, a leading expert in systems thinking, writes that "Systems thinking provides guidance and direction for exploration of an organization and its goals for change. It describes the complex relationships between people, tasks, and technologies and helps us to see how these can be used to enhance organizational performance" (Pasmore & Sherwood, 1978). Additional definitions are provided in Table 2.

Open Systems theory provides an important foundation for developing a comprehensive Open Systems approach. Interdependency through connectivity of Open Systems theory is a foundational layer that underpins the goals of Open Systems. However, connectivity is not necessarily hardwired or continuous; rather, it may be established through digital means when appropriate and on an as-needed basis.

FURTHER DEFINING OPEN SYSTEMS

Open Systems are about the entities, their relationship patterns, boundaries of the systems, and the environment(s) in which the systems reside. One of the best characterizations of an Open System is summarized by the frequently paraphrased statement: If you put 20 people in a room, you can find at least 20 different definitions for Open Systems.

The DoD's OSJTF defines Open Systems as "a system that employs modular design, uses widely supported and consensus-based standards for its key interfaces, and has been subjected to successful validation

TABLE 2. COMPARISON OF DEFINITIONS

Agency Institution	Definition
SEI	A system that implements sufficient open specifications for interfaces, services, and supporting formats to (1) enable properly engineered components to be utilized across a wide range of systems with minimal changes; (2) to interoperate with other components on local and remote systems; and (3) to interact with users in a style that facilitates portability.
OSJTF	A system that employs modular design, uses widely supported and consensus-based standards for its key interfaces, and has been subjected to successful validation and verification tests to ensure the openness of its key interfaces.
Webopedia	An architecture whose specifications are public. This includes officially approved standards as well as privately designed architectures whose specifications are made public by the designers. The opposite of open is closed or proprietary.
IEEE POSIX 1003.0/D15 as modified by Tri-Service OSA Working Group, Nov. 1995	A system that implements sufficient open specifications for interfaces, services, and supporting formats to enable properly engineered components to be utilized across a wide range of systems with minimal changes. An open system is characterized by the following: • Well-defined, widely used, non-proprietary interfaces/protocols • Use of principles that are developed/adopted by industrially recognized standards • Definition of all aspects of system interfaces • Explicit provision for expansion or upgrading.

and verification tests to ensure the openness of its key interfaces" (Open Systems Joint Task Force, n.d.). Further definitions of an Open Systems approach encompass several key elements and ideas associated with Open Systems. Some of these key elements are established industry protocols, standards, and interfaces. Table 3 also addresses Open Systems components. Additional characteristics of Open Systems follow (Open Systems Joint Task Force, n.d.):

- Use of developed, adopted, and recognized standards
- Well-defined, widely used, non-proprietary interfaces/protocols
- Standing governance bodies regulating Open Systems standards

TABLE 3. COMPONENTS OF OPEN SYSTEMS THEORY

Component	Explanation
Entity	A system entity can be an individual, group, technology, or a combination that comprises the organizational system.
System Boundary	The system boundary is the border that delineates it from other systems and the environment. It is permeable, allowing interaction between the system and its environment. Properly identifying the boundary helps determine the complexity of the organization's policy decision and ultimately the analysis. This boundary provides the contextual environment that the policy decision will affect.
Pattern of Relationships Between Entities	The pattern of relationships between entities interconnects all entities within the system, but all entities do not have to connect to each other. A connection or relationship does not have to be two-way.
Environment	The local environment consists of entities or systems that have a habitual association and critical effect on the system. The global environment is the larger environment that encompasses the system. It includes systems outside the parent organization. Analysts must carefully define the boundaries of local and global environments so as not to invite unwarranted complexity or overlook important interactions with the system.

- Definition of all aspects of system interfaces to facilitate new or additional systems capabilities for a wide range of application
- Explicit provision for expansion or upgrading through the incorporation of additional or higher performance elements with minimal impact on the system.

GOALS AND CHALLENGES

The success of Open Systems depends largely on defining, implementing, and satisfying goals at hand. The goals that are established to accomplish Open Systems must be evolutionary in nature because of the magnitude of systems and the dynamic environment of the DoD. The OSJTF charter has published goals that apply to all Services (Open Systems Joint Task Force, n.d.).

The OSJTF must oversee the military departments' transitions to Open Systems-centered acquisition and advise acquisition executives on Open Systems implementation. Also, OSJTF must act as the lead standardization activity for Open Systems weapons electronics and plan the transition of this role to a permanent activity. It must also coordinate and support DoD participation with appropriate industry standards bodies for non-Information Technology (IT) standards. For IT standards, OSJTF will support the executive agent in developing and representing the DoD position.

Other OSJTF goals include establishing sources of training in Open Systems; establishing a repository that facilitates the communication of Open Systems ideas, implementations, techniques, and technologies; designating appropriate Open Systems standards for DoD weapons systems use; and coordinating with the executive agent for IT standards and forwarding IT standards issues to the executive agent for resolution.

Some specific points from the OSJTF charter highlight various challenges that the Army faces as it works to implement Open Systems.

- Cost, interoperability, modularity, technology transparency, and supportability of the various systems create significant management demands.
- Current efforts are still somewhat fragmented and stovepiped, relatively narrow, and are limited primarily to computers and bus structures.
- The air-, land-, and sea-based communities have too little interaction.
- The intended foci of the OSJTF are weapons systems and platforms, not Command, Control, Communications, and Intelligence (C3I) systems, communications networks, or non-real-time, data-processing functions.

Another implicit goal of Open Systems is to integrate hardware, software, systems, and people within the live, virtual, and constructive training and warfighting environments. However, the OSJTF will not attempt to force the use of common hardware everywhere; rather, it will seek to standardize to each unique need while retaining the advantages of common architecture and major interfaces (Open Systems Joint Task Force, n.d.).

The OSJTF's role, as well as DoD's, is a top-down leadership role, providing guidance and resources and coordinating across Services and major agencies to establish policies. Furthermore, there is a bottom-up mandate that requires agencies to provide the daily direction, guidance, and resources required to implement an Open Systems environment.

THE TRANSFORMATION LIFE CYCLE: GOING FROM CLOSED TO OPEN

Along with establishing an Open Systems approach, the implementation of a Transformation Life Cycle is also important (Transformation Life Cycle, n.d.). A Transformation Life Cycle is an approach that can help the government and corporate entities understand, plan, and develop their systems to meet requisite standards of interoperability. Similarly, an approach of this type can help the government achieve an alignment between itself, academia, and commercial enterprise business practices. The Transformation Life Cycle will also allow for implementation that crosswalks technology (i.e., legacy, current, and future), with anticipated capabilities leading to integrated and interoperable systems results.

As previously described, Open Systems is not in and of itself a software product; rather, it is a set of protocols, standards, and a hierarchical structure from which software and hardware are built to ensure that they incorporate and pass information in an integrated and interoperable manner. Additionally, other architectures, standards, and protocols are in use throughout DoD; some of these are described below.

OTHER APPROACHES (HLA, DIS, AND SOA)

In addition to Open Systems, other architectures, protocols, and standards have been, and continue to be, widely used by DoD and industry. Some of these include DoD's High Level Architecture (HLA), Distributed Interactive Simulation (DIS), and Service-Oriented Architecture (SOA). These have, in some manner, facilitated the integration of hardware, particularly software, bringing the constructive, virtual, and live environments together into a coordinated learning environment for training, mission planning, and mission rehearsal.

HLA, developed by the Defense Modeling and Simulation Office (DMSO), was designed to support the interoperability of various DoD simulations. HLA was approved as the standard technical architecture

for all DoD simulations by the Under Secretary of Defense for Acquisition and Technology in September 1996, and was later approved as an open standard by the Institute of Electrical and Electronics Engineers (IEEE) in September of 2000 (Defense Modeling and Simulation Office, n.d.).

Additionally, HLA has been an essential architecture, supporting the integration of disparate constructive simulations, as well as virtual simulators and live systems. As previously stated, HLA is not software; rather, it is a hierarchical architecture from which the adherence standards and protocols provide the integrating glue, connecting the Live, Virtual, and Constructive (L-V-C) system environments.

Furthermore, a principal element of the HLA architecture is the Runtime Infrastructure (RTI). RTI coordinates the events from each system environment, facilitating the data exchange and operations and allowing the L-V-C environment to work in a federate manner. Essentially, the simulation systems work as a collection of simulators that share information and are thus changed as a result of the shared events.

DIS is also a useful tool. DIS allows multiple users to work interactively within the same or integrated simulation environment. Examples are the distributed, Internet-based America's Army game or a federated war game, which is run at multiple locations. It is clear that a federated model using HLA can also be DIS.

DIS is built on Local Area Networks or Wide Area Networks and depends largely on the robust capability of the network to handle the data and information-exchange transmission rate. A well-designed DIS has four basic features (Qin, 2002):

- Proper interpretation of time
- Consideration of operation transmission delays
- Execution of operations in correct order
- Allowance of real-time response.

DIS is an important aspect of a simulation environment. Often, bringing each simulation system to a single location, establishing connectivity, and then running the integrated environment are not feasible or cost-effective. Thus, DIS allows simulations to interconnect via a network backbone.

The basic underlying concept of an SOA is a coupling of multiple services within an architectural structure. These services are called upon by customers to support their business requirements. The Organization for Advancement of Structured Information Standards (OASIS) defines SOA as "a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with, and use capabilities to produce desired effects consistent with measurable preconditions and expectations" (OASIS, n.d.).

An important aspect of SOA is that it provides a means to make services interoperable regardless of the programming language used, location, or platform of a simulation or model. This allows organizations and agencies to produce their software on an appropriate platform, using architectural guiding principles and specified standards and protocols, linking these resources in defined and spontaneous ways to produce results or information. Additionally, this promotes reuse, interoperability, and growth and can help organizations respond to ever-changing and increased demands for information in a more cost-effective manner.

Overall, the relationship of HLA, DIS, and SOA to Open Systems is that each provides a step in the right direction and expands across systems to incorporate their resident capabilities and data into a more integrated and interoperable environment.

ACHIEVING GREAT PERFORMANCE THROUGH OPEN SYSTEMS

Designing, integrating, and evaluating systems and System of Systems architectures to achieve ever greater performance and capabilities while controlling development and sustainment costs present perplexing problems for warfighters, engineers, analysts, and decision makers. Furthermore, these individuals continue to face the increasingly difficult task of integrating these complex simulations and live systems to train, plan, and rehearse—a strategy designed to make U.S. warfighting capabilities a formidable, unstoppable force against any adversary.

The preceding priorities must be accomplished in any environment along the complete spectrum of operations, from humanitarian assistance to full-scale, force-on-force operations. Current employed systems comprise legacy equipment and current technology, but must have the capacity to incorporate future technological advances as they matriculate through development and are incorporated within existing force structures. The greater introduction of space and cyber assets into our Army force structure will exacerbate even further the requirement for Open Systems that effectively and efficiently integrate these domains into the brigade combat team (BCT). Facilitating this critical integration and interoperability requirement necessitates an Open Systems approach.

INTEROPERABILITY AND PHYSICAL CONNECTIVITY

As a basic proposition, interoperability is the ability to work together (Alberts & Hayes, 2003). The importance of interoperability is not at the connectivity of systems within an L-V-C environment; rather, its importance is manifested at the information and cognitive levels.

Having physical connectivity is important. However, this is simply the starting point. And for many, this is often where the discussion stops

because warfighters, analysts, engineers, and stakeholders become trapped in the details of bandwidth, platforms, cost, etc. This social standard is transferable to physical L-V-C systems.

Without interoperability, there would be no physical connection (i.e., a social wave between systems), which opens channels to pass information for sharing and allows warfighters to understand issues and situations, and consequently plan and implement courses of action designed to achieve success. With interoperability, the Army Aviation hunter-killer team is able to detach from each other, coordinate and communicate via their physical connection, and share information and understanding to hunt and kill in a distributed manner. Likewise, the Army's greater and greater reliance on commercial-off-the-shelf (COTS) technology necessitates the need for interoperability standards and protocols to better integrate these force multiplier and lifesaving technologies into operational environments.

A USEFUL BLUEPRINT

Open Systems standards and protocols provide a blueprint from which a purposeful design integrates L-V-C systems and facilitates interoperability. The true goals of interoperability are shared information and ultimately shared understanding. To achieve these goals, standards and protocols must be developed within the social structure of "humanness," which will enable the achievement of interoperability.

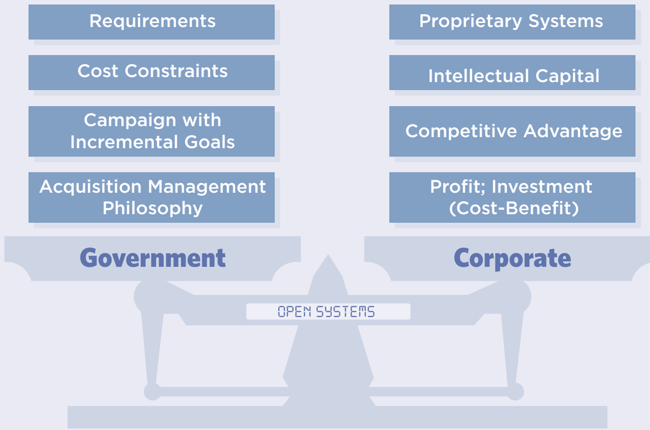
Without a common language or the ability to translate different languages so that entities can communicate, sharing information and gaining understanding would be impossible. For example, humans have developed a standard of greeting, which consists of a handshake or a wave of the hand. Both signify a non-threatening recognition and acceptance, and they open the opportunity to connect and communicate. Likewise, Open Systems provide a similar connection between entities.

OTHER ISSUES

A number of impediments with which DoD is confronted still exist, which are counter to achieving enterprise-wide Open Systems. The most prominent is cost. Open Systems architectures create a performance and cost escalation. For instance, interfaces within components that are strictly controlled to achieve performance gains often become proprietary, and thus increase the cost to the government. Additionally, the development and life-cycle sustainment costs of integrating legacy systems with future systems across DoD are prohibitive when addressed in total. This is one of the reasons that DoD leadership is tackling this requirement incrementally.

Closely associated with cost is the articulation and inclusion of requirements for the development and modification of systems to facilitate forward and backward compatibility of Open Systems standards

FIGURE. DoD AND CORPORATE BUSINESS PRIMARY NEEDS TO ACHIEVE OPEN SYSTEMS



and protocols. Without the vetted and approved requirements mandating the acquisition (i.e., government and commercial) standards that must be met during the systems development phase of a program, Open Systems will be ignored.

However, the requirements process can be a double-edged sword. Though it clearly mandates that a program manager or material developer meet the requirements, the interpretation of requirements can lead to a cost that is far beyond the intent, causing a scaling back of the requirement intent and ultimately the level of interoperability across DoD L-V-C systems. This situation starts the trade-space analysis.

Alternatively, the interpretation of requirements can lead to a cost that is far less than the intent, again thwarting the goal of achieving Open Systems. What is needed is a balance (as depicted in the Figure) between the DoD's needs and corporate business imperatives, and also the ability to deliver Open Systems.

As demonstrated, DoD must develop an environment that is designed to encourage technology development and competition within an Open Systems framework. This will require strong, earnest leadership and governance. This leadership and governance must be top-down and must have consistency over time, as DoD is a customer with high expectations.

Open Systems Solutions

The governance of the Open Systems approach must be continually reviewed and updated to provide a success-driven environment. The Army recognizes the importance of governance and thereby creates a means to implement Open Systems by socializing, formalizing, resourcing, and implementing processes to transition from closed to Open Systems.

The Army also evaluates systems throughout the acquisition process to ensure that they meet Open Systems standards. The governance of this campaign should adopt the Open Systems framework and should be the decision-making, regulatory, and enforcement structure to ensure that requirements, standards, and protocols are met. For example, new initiatives like a new architecture require that the agency either fund for the mandate or nurture a community of interest that will provide input and see benefit to incorporate such models.

Corporate entities that support the DoD are not expected to act as patriots. Rather, they should manage the customers' expectations and should work with customers to craft appropriate strategies to achieve Open Systems. They should also recognize that cost is a significant factor, and that incremental steps must be funded.

These incremental steps should be framed within an overall, larger encompassing campaign, focused on a sector of the defense industrial complex. DoD and corporate partners must come to terms with the balance of client needs and funding realities to profit, proprietary rights, and intellectual capital. The solutions are both political and technical.

At the same time, bottom-up champions who are dedicated to achieving a comprehensive, integrated L-V-C Open Systems environment are needed. Additionally, these implementers need to develop proof-of-principle facilities that work collaboratively with the materiel developers to test and validate that the systems meet Open Systems standards and protocols, and to be certain that they are truly integrated and interoperable. These champions must also be funded and empowered to make decisions within the established governance framework, and must make appropriate changes and take those changes to the executive governance body for decision.

Overall, implementing and maintaining an Open Systems approach is an involved yet essential requirement. Due to the nation's current state and the increasing demands placed upon the Army, new and innovative systems of technology are consistently needed and required. Certainly no system is without concerns or impediments, and the Open Systems approach is no exception. However, if problems are addressed as needed and if proper governance is in place, Open Systems can be achieved. The result of an Open Systems architecture is the development of an environment that provides the training, mission rehearsal, and warfighter planning that support our Army—all of which will sharpen our warfighting edge and ensure our dominance across the full spectrum of operations.

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APPENDIX

List of Acronyms

AMRDEC	Aviation and Missile Research, Development, and Engineering Center
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
HLA	High Level Architecture
IEEE	Institute of Electrical and Electronics Engineers
IT	Information Technology
L-V-C	Live, Virtual, and Constructive
OASIS	Organization for Advancement of Structured Information Standards
OSJTF	Open Systems Joint Task Force
RTI	Runtime Infrastructure
SEI	Software Engineering Institute
SOA	Service-Oriented Architecture

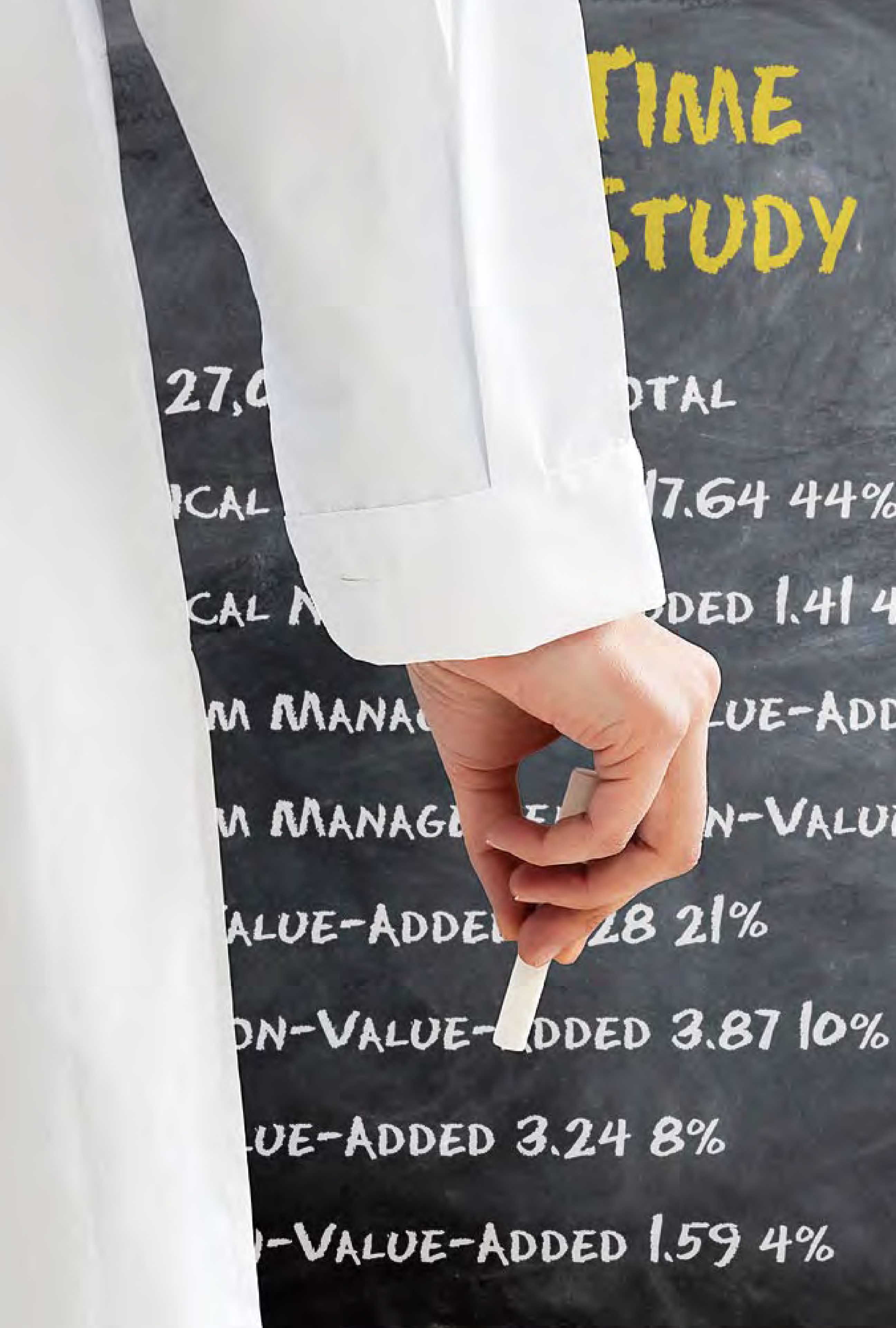
A TIME STUDY OF SCIENTISTS & ENGINEERS (S&Es) IN THE AIR VEHICLES DIRECTORATE

JoAnn McCabe and Col John Wissler, USAF

The Air Vehicles Directorate of the Air Force Research Laboratory, concerned that its scientists and engineers (S&Es) were spending more time on nontechnical duties than on technical duties, developed a Web-based means of gathering data on this issue. After almost 27,000 hours, recorded data showed approximately 19 of 40 hours in an average week were spent on technical taskings. This led the directorate to examine various ways of increasing the share of technical time productivity reported by its S&Es. This article highlights the authors' data gathering results and offers insights on increasing the technical and value-added time of S&Es, thereby resulting in increased productivity for AFRL—an important Air Force resource.

Keywords: *Time Study of Scientists and Engineers, Air Force Research Laboratory (AFRL) Research, Air Force Research Laboratory Time Study, How Scientists and Engineers Spend Their Time, Technology-Focused Research Organizations, Value and Non-Value Added Work in a Government Laboratory, Research Day*

image designed by Elizabeth Bailey »


TIME
STUDY
7.64 44%
DED 1.41
ALUE-ADDE 28 21%
ON-VALUE- DDED 3.87 10%
UE-ADDED 3.24 8%
-VALUE-ADDED 1.59 4%

The Air Vehicles Directorate, located at Wright-Patterson Air Force Base, is one of the 10 technology-focused research organizations in the Air Force Research Laboratory (AFRL). We employ approximately 600 people, close to one-third of whom are government scientists and engineers (S&Es), and develop advanced flight vehicle technologies in the areas of aerodynamics, control of flight vehicles, and structural sciences. Our work is analytical, computational, and experimental, accomplished in both in-house and external facilities, and involving programs with academia and industry. Although our natural focus is on the long-term future, we also solve shorter-term, more urgent problems for the Air Force.

The Air Vehicles Directorate and its predecessor organizations have a long history, and our technologies can be found in practically every major weapon system in today's U.S. Air Force inventory. In response to budget cuts, drives for efficiency, and numerous reforms, the workforce in the Air Vehicles Directorate has declined 16 percent in the last decade (C. Remillard, personal communication, April 10, 2008). Many of these cuts resulted in the reduction of non-technical personnel, thus often leaving some nontechnical taskings to our S&Es.

Concern regarding the DoD's acquisition workforce capability and competency is increasing (Taubman, 2008). At the organizational level, anecdotal evidence supports the view that our technical workforce does not feel it accomplishes enough technical work. This view is a frequently cited frustration that has been noted in recent cultural surveys and exit interviews, and discussed during formal and informal mentoring sessions. Concerns have been raised at director's calls, overheard in the hallways, and documented by supervisors during feedback sessions. These concerns have continued despite initiatives such as Air Force Smart Operations for the 21st Century (AFSO-21) and business process reengineering, which are directed at reducing non-value-added work, increasing our S&Es' *bench time*, and making the most of AFRL's technical talent. AFSO-21, introduced by former Secretary of the Air Force Michael Wynne in his Secretary of the Air Force Letters to Airmen in December 2005 and March 2006, described it as "a dedicated effort to maximize value and minimize waste in our operations" (Wynne, 2005, p. 1; Wynne, 2006, p. 1) and "AFSO-21 is about working smarter to deliver warfighting capabilities" (Hudson, 2006, p. 5).

According to Lt Gen John L. "Jack" Hudson, USAF, commander of the Aeronautical Systems Center in a Commentary dated September 15, 2006, "Our mission of providing warfighting capabilities has never been more important, and we must continually find ways to do this more efficiently and effectively, despite manpower and budgetary constraints. AFSO-21 will help us do that" (p. 1). According to Jenkins (2009), there is a need for having a framework for workplace satisfaction and organizational commitment. Jenkins states that this framework, "integrates McGregor's Theories X and Y, Maslow's hierarchy of needs, and Meyer and Allen's

three-part organizational commitment theory" (pp. 21–23). Jenkins lists factors related to workplace satisfaction: pay and benefits; growth and development opportunities; relevance or meaning of job; supervision; and feelings towards co-workers. What is not listed as relevant is the fact that many of our S&Es simply want to do what they do best: engineering and science. A key part of that is assessing how much engineering and science they are actually doing.

In general, the feedback from our workforce is that people want to concentrate on their research and technical work, i.e., the *intellectual* work associated with their core duties, *not* the excessive program management and administrative responsibilities required to support that work. So the question was asked: How do S&Es in the Air Vehicles Directorate spend their time?

The Approach

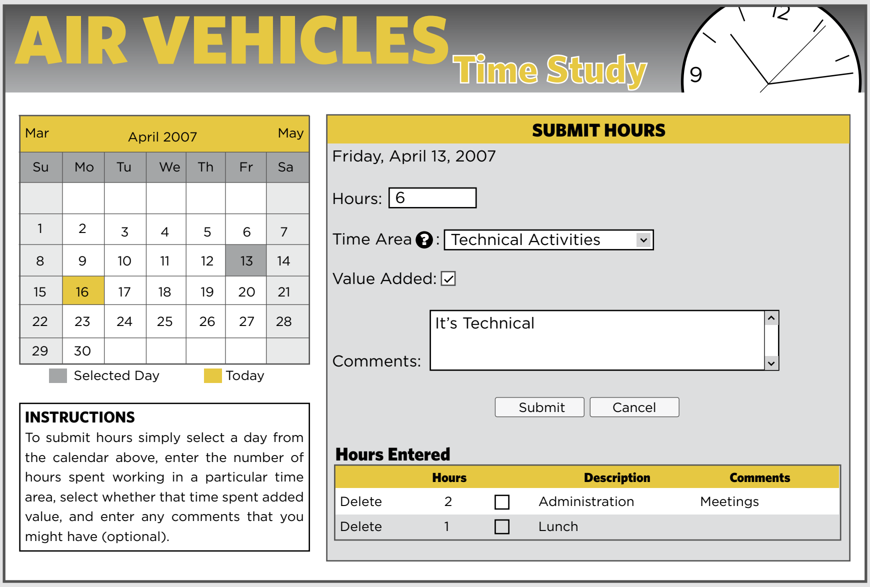
To answer that question, we first needed a way to gather data about how our S&Es spend their time. One possible approach was to use the organization's existing timekeeping system. However, this system only tracks the amount of *time* our workforce charges to their projects, not the *type of task performed* in support of those projects. Another challenge was working with a relatively small population. Statistically, in order to attain a 95 percent confidence interval, we would have needed 122 respondents. Given not everyone would take the time to submit data, we instead chose to conduct a census and invite all our S&Es to participate, after which we would accept whatever we could get. Admittedly, we were less concerned about confidence intervals and absolute statistical rigor than we were about identifying issues and trends and taking steps to address them. We would then use the information to help us increase the time each S&E spent in technical activities and increase the value-added aspects of the S&Es' work.

We developed an intranet Web site that would enable us to collect:

- Number of hours worked in various activity/category types
- Whether the hours worked were considered by S&Es to be value- or non-value-added
- Comments, especially if the S&Es reported the activity to be of no value.

To encourage participation, we ensured the anonymity of each respondent providing the information and designed the site so that it took less than 5 minutes each day to complete.

FIGURE 1. INTRANET WEB SITE FOR RECORDING TIME STUDY INFORMATION



The Web site is shown in Figure 1. To the left is a calendar showing the date and the day for which data was being entered. The right hand side contains a number of items to be filled out, such as the number of hours worked on a particular activity, the activity performed, a value indication, and a text entry box for any comments the submitter cared to make. At the bottom of the site is a table (Hours Entered) that displayed the data as the respondents entered it. Once respondents logged into the Web site, they simply entered the data regarding their activities for that day. The Web site was designed so that if they missed a day, respondents could click on the missed day and enter the data. Only activities in the standard workday (nominally a 40-hour federal work week) were to be logged.

Prior to launching the 2-month Time Study, we ran a 1-week beta test that resulted in the refined categories shown in the Table, which also shows the four major categories into which the data were binned: Technical, Program Management, Administration, and Miscellaneous. Note that Program Management consists of only one subcategory that covers administratively oriented tasks associated with program management, such as putting program budgets into the management information systems. We characterized the intellectual tasks associated with program management as technical (e.g., technical planning).

Then, in July 2007, we had an all-hands meeting with our S&Es, during which we provided them with an overview of the Time Study, including a demonstration of the Web tool. Additionally, we asked the S&Es for their support and stressed that individual identities would be masked.

The data collection period ran for 2 months (July and August 2007). To help our census respondents remember to fill out the questionnaire, our Web Team issued periodic pop-up reminders on the network; we also sent them periodic e-mail reminders. Additionally, the Air Vehicles director would send periodic e-mails asking people to participate. Not unexpectedly, these resulted in increased participation.

Results

In total, over the 2-month period, approximately 27,000 hours of time data were logged by the S&Es in the Air Vehicles Directorate. To make the data more relevant to the average S&E's activities, we normalized the data into the standard 40-hour work week, thus creating the picture of an *average* S&E.

Figure 2 shows the top-level results. Technical activities comprised slightly over 19 hours per week for our average S&E, and Program Management accounted for another 4 hours. Administrative and Miscellaneous activities accounted for the remaining 17 hours. Thus, it appears that the majority of our average S&E's time is spent on either Technical or Program Management, although only by a slim majority.

Figure 3 shows the same data, now accounting for the value-added versus non-value-added time. It shows that our S&Es reported non-value-added activities in all categories. However, nearly one-third of

FIGURE 2. TOP-LEVEL RESULTS—SCALED TO A 40-HOUR WORK WEEK

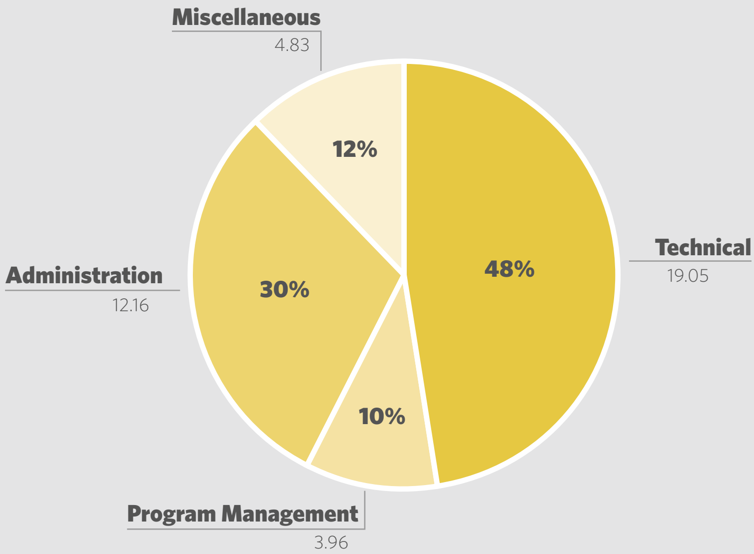


FIGURE 3. TOP-LEVEL RESULTS—VALUE ADDED VS. NON-VALUE-ADDED

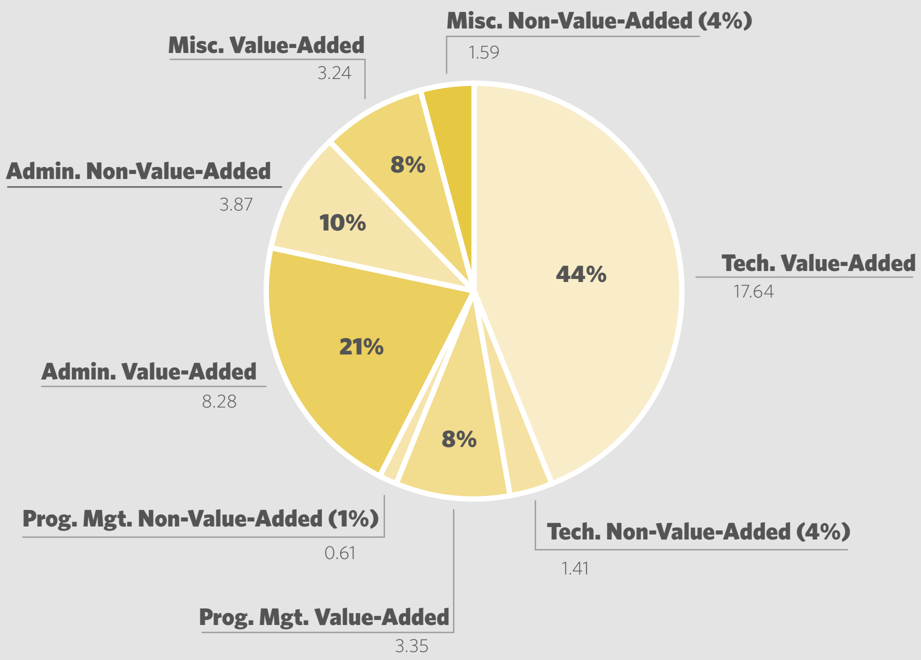


FIGURE 4. COMPARISON OF VALUE-ADDED TIME—MILITARY S&Es VS. CIVILIAN S&Es

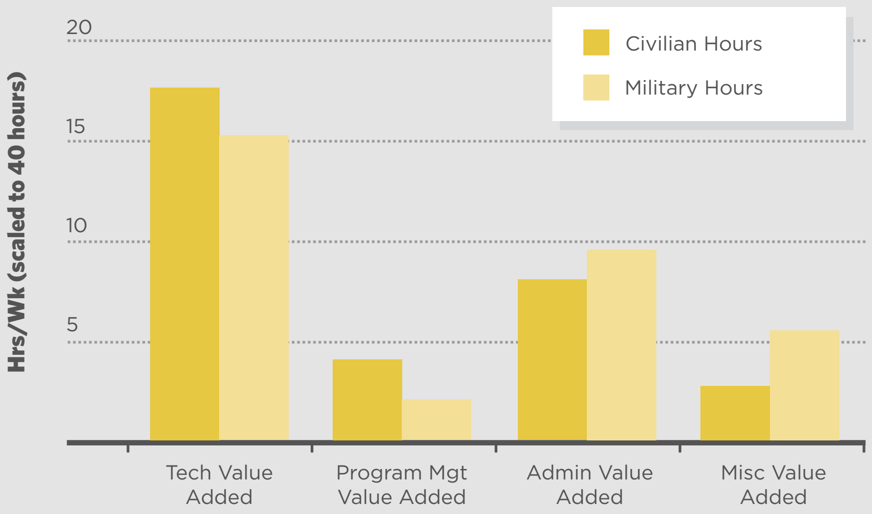
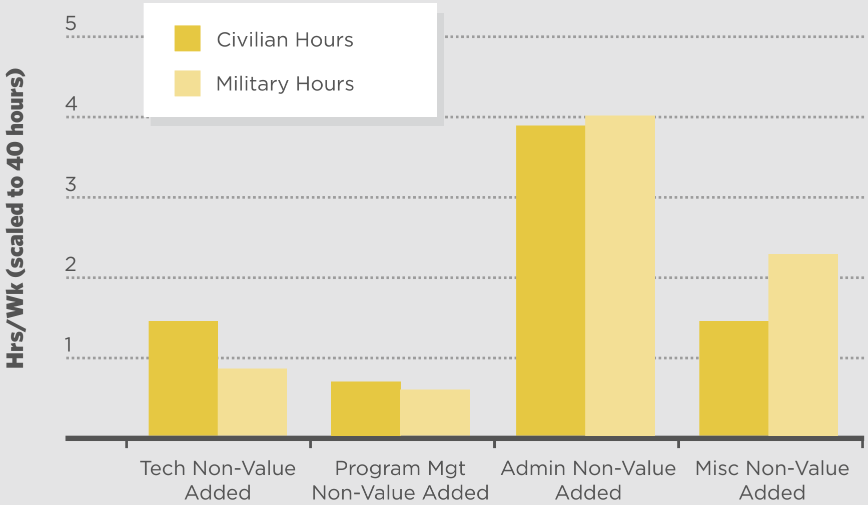


FIGURE 5. COMPARISON OF NON-VALUE-ADDED TIME—MILITARY S&Es VS. CIVILIAN S&Es



the administrative activities accounted for were viewed as non-value-added—the largest percentage among all four categories. The program management category showed the lowest absolute amount of non-value-added activities, but on a percentage basis within a category, our S&Es felt that technical activities had the largest value (as one would expect).

Figure 4 shows how our military S&Es, mostly junior officers (second lieutenants through captains), compare to our civilian S&Es, who fall within a broad spectrum of grades, from GS-11 to GS-14 equivalent. It shows that civilian S&Es reported a slightly greater share of value-added hours for Technical and Program Management activities, while military S&Es reported a slightly higher value-added share for Administrative and Miscellaneous tasks.

Figure 5 shows the same data for non-value-added activities. It shows that the military perception of non-value-added activities is slightly higher overall, with the biggest difference between civilian and military being in the miscellaneous category.

Discussion

Surprisingly, the results countered to a certain extent the anecdotal evidence that our S&Es spent little or no time on technical activities, painting a good news/bad news picture. Clearly, close to one-half of a 40-hour work week was spent on technical work (good news; after all, our S&Es perceived they did little or no technical work!). However, the bad

news was that technical work comprised *only* 19 hours a week. It indicated we can use our employees' time more wisely.

Although the non-value-added component was lower than we originally expected, it nonetheless comprised almost a full day out of a 5-day week. Again, it was a good news/bad news story. The good news was that it was only a day and not 2 or 3 days. The bad news was that it was a day and not a half day or less. We assume it is impossible to drive it to zero (after all, we *are* part of the federal government!). But, we should be able to drive it to less than a day. We recognize that different people in different jobs have different perceptions of value; most of our S&Es view the major share of the administrative work they do as having little or no value.

One area of concern is the data that shows our military junior officers doing more administrative and miscellaneous work as compared to their civilian counterparts. To a certain extent, this makes sense; many of our additional duties tend to be administrative in nature and tend to fall into the laps of our officers. However, given that we are theoretically preparing our young officers for increased responsibility, one has to ask whether placing the administrative and miscellaneous burden on them is the best use of their talents and the best way to develop them. Certainly, their academic background and officer training could be better utilized, especially given the fact that our S&E workforce has declined in number.

Before we took on the challenge of reducing the number of non-value-added tasks in an S&E's work week, we checked out our concerns with Air Force pilots and leaders from industry. We asked several Air Force rated officers: Would it be acceptable if line pilots spent only half their time thinking about, preparing for, or actually flying? The consensus was that it would not be acceptable. The obvious question for the Air Force is, if spending less than half one's time on core duties is unacceptable for the flying community, then why should it be acceptable for the technical community?

We then asked several of our industry counterparts how their engineers spent their time. Their responses left us with the sense that although they probably spent more than half their time on technical work, a large portion of their time was also spent on marketing and business development. Our industry colleagues also said that most companies try to get the most out of their highly trained and well-paid technical workforce and do this partly by offloading as much administrative work as they can to nontechnical personnel.

The next question is: Now what? We want to make the most of the technical talent we have in the Air Vehicles Directorate. We want to look at *non-value-added* efforts, and we want to increase bench time for S&Es because we believe it represents better value for the American taxpayer; and it is clearly a morale, motivation, and recruiting issue.

The directorate's leadership identified three possible initiatives we anticipate will increase the bench time of our S&Es. The first initiative, The First Three Years Program, is an Air Force Research Laboratory-wide program. The second initiative is the hiring of technical business specialists to assist the S&Es, and the third initiative is the implementation of Research/Focus Day.

THE FIRST THREE YEARS PROGRAM

In a move to ensure every newly hired federal civilian service S&E and lieutenant can become a successful technology leader (i.e., researcher, program manager, or supervisor), AFRL implemented The First Three Years Program. The program's goal is to allow young S&Es to become comfortable with the laboratory environment from a bench-level perspective before taking on more complex program management functions. The program requires supervisors to assign technical mentors to oversee the technical training of our S&Es during their first three years of employment (Fast, 2009). Its basis is the belief that the primary function of bench-level military and civilian S&Es is to perform mission-focused science and technology work for their first three years, as well as reviews of management literature concerned with the career management of scientific personnel (Clarke, 1996; Farris & Cordero, 2002). The mentors oversee the technical training of our new S&Es, with both on-the-job training (OJT) and formal training. A formal Individual Development Plan (IDP), required for each employee within the first 60 to 90 days of assignment and outlining both formal and OJT assignments, helps the employee and the supervisor map out a strategy to help new S&Es contribute quickly and effectively.

TECHNICAL BUSINESS SPECIALISTS

Based on this study's results, we determined that decreasing administrative workload on S&Es is clearly a necessity. Hiring additional government S&Es to perform this duty, however, is not a practical option because the Air Force places limits on manpower authorizations. This solution is also completely counter to increasing the technical content of what our S&Es do.

A different option is to hire a small number of government business specialists to perform basic program management tasks. Specifically, we decided to hire six technical business specialists, two of which would be assigned to each of the three technical divisions to become part of the program manager support team. S&Es will remain assigned as program managers, and the new specialists will augment any personnel currently doing similar duties within the division. The administrative burden that the technical business specialists remove from the S&Es will free a significant

portion of the S&Es' work week, allowing them to focus on core technical activities, reduce the program management workload, and increase the time spent performing research. Our S&Es have reacted positively to this new practice, which has acted as an unexpected motivator. The S&Es accurately interpreted the proposed practice that management values their research and development time. As pointed out by Ralph Katz (1997), if technical employees believe their work is challenging and innovative, and if they have the freedom to do what they do best, they will work to meet the demands the research calls for.

A potential argument against filling these positions is that they increase the number of administrative personnel relative to the S&Es, thereby reducing the "tooth-to-tail" ratio. However, we would submit that tooth-to-tail is more than just a body count. It is also the kind of functions that people in those positions actually perform. Having an expensive and technically trained S&E perform functions that could easily be done by a nontechnical and less expensive business specialist in effect makes the tooth-to-tail ratio worse, not better. This is especially true if several S&Es perform work on a part-time basis, thus doing that work inefficiently while the per hour cost is higher. Having the technical business specialists perform some of the critical nontechnical functions will increase the efficiency with which those functions are accomplished, enable the S&Es to spend more time on the technical intellectual content of what they do, and also increase morale, recruiting, and retention.

RESEARCH/FOCUS DAY

Probably the most controversial idea we implemented may prove to be the most beneficial. The directorate has designated every Thursday as a day in which each employee is asked to spend their time working only on their *core* function, whether it be technical or nontechnical. One of our employees said it best when he responded to the question: What should we be working on? His response was: "On Research Day, do what you would do if you had to come in on a Saturday to get done what you couldn't get done during the week. That's what you should be working on" (T. C. Hummel, personal communication, August 30, 2007).

To help personnel concentrate on these core tasks, the directorate refrains from issuing new administrative taskings on Thursdays, and requests that non-core training and meetings be deferred to another day. Employees are also encouraged to minimize e-mails. Directorate leaders (branch chiefs and above) are expected to walk around and ensure that personnel are following the rules of Research/Focus Day. Surprisingly, the hardest part of implementing it has been getting people to think about their core duties and then have the discipline to focus on them. This may be a symptom of the fragmented nature in which we have operated. In any

case, we are continuing to emphasize the use of Thursdays and the need to use them to concentrate, not fragment.

Conclusions

Clearly, the Time Study was a first attempt to define and break down how Air Vehicles Directorate S&Es spend their time. We are considering repeating the Time Study in fall 2009. We will compare the results of the original study and look at other assessments directed at our workplace environment.

As we continue to develop our personnel and provide them with meaningful work, increasing the time spent by our military and civilian technical personnel on technical tasks must remain a priority. Increasing the amount of time spent on technical tasks represents a best-value proposition for the Air Force because it maximizes the payoff associated with hiring S&Es. Additionally, the working environment is also improved because through the conduct of this Time Study and responsive follow-up actions, our workforce understands that we listen to them, we hear them, and we are taking their best interests to heart.

ACKNOWLEDGEMENT

The authors would like to acknowledge the excellent support by the Air Vehicles Directorate Web Team: Charles Aliaga, Teresa Connair, and Anthony DeCerbo of RCF Corporation, Dayton, Ohio.

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TECHNOLOGY CORNER:

THE **REAL** CHALLENGE OF WEB 2.0

Mark Oehlert

The hardest part about implementing "Web 2.0" or "Social Media" within the defense acquisition workforce is not acquiring new technology, successful change management, or organizational design. The most difficult challenges confronting users of this new technology are not monetary, functionality, or even integration; rather, the most difficult challenges are difficult questions about how the workforce regards the dynamics of fear, control, and trust within their own organizations. Can these very human questions be answered in a manner that most fully exploits the capabilities that are now open to the acquisition workforce? In this article, the author seeks to answer that question and provide insight and close examination of this new 21st century phenomenon called Web 2.0.

Keywords: *Web 2.0, Social Media, Culture, Change Management, Organizational Design*

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INTERNET
COMMUNITIES
CREATIVITY
BLOGS
WWW
PRIVACY
WEB 2.0
NETWORK
WIKIS
VIDEO SHARING
INTERACTIVITY
SOCIAL NETWORKING
PARTICIPATION

Instead of pouring knowledge into people's heads, we need to help them grind a new set of glasses so they can see the world in a new way. That involves challenging the implicit assumptions that have shaped the way people have historically looked at things.

John Seely Brown

The quote that begins this article speaks to humanity's common need to avoid assumptions of the past in order to move forward (Brown, 2003). At no time in history have assumptions of the past been left so far behind in the dust as in the past quarter century. The Information Age has ushered in the phenomenon of the Internet—a global cultural gift to mankind that, in recent years, has spawned its own technological child: "Web 2.0" or "Social Media." This article briefly examines the profound effect of social media on the way we work and learn.

Working under a research grant approximately 10 years ago, this author interviewed a number of managers who had been in charge of implementing Learning Management Systems (LMS) within their organizations. One question posed asked them to name the largest single hurdle to the successful installation and integration of the LMS. Was there sufficient funding? Yes. Staffing? Yes. Were there hiccups in technical terms? Sure, but nothing catastrophic. What then was this single greatest hurdle to success? In every organization, the answer was insufficient organizational design and change management. So then the question was posed to the LMS vendors: Do you provide any organizational design or change management services with your products? None did. The history of LMS is now replete with stories of companies on their third, fourth, and fifth LMS installs. Herein lies the lesson of history and the real challenge of Web 2.0.

Sometimes, it feels like the challenge of 2.0 or social media is one of keeping up with technology. Seemingly, a new tool is created and launched in a matter of seconds versus the pace of 2.0's predecessor technology. Right now, around 100,000 apps are available for the iPhone alone (Farrell, 2009). More and more, the real challenge appears to be one of security. This author was fortunate enough to serve on the working group that helped, in some small part, to craft the current (as of October 2009) draft of a DoD-wide policy for social media usage that is currently being coordinated. A quick review of articles on this topic (Bezier, 2009) and the actual comments coming back from the field pinpoint a level of concern over the exposure of systems or classified information. This concern, however, as interpreted by the author from both the articles reviewed and comments from the field, clearly translates into an element of distinct anxiety.

The challenge that the defense acquisition workforce and all of the Department of Defense faces in implementing the benefits of social media lies in the ability to confront the Three Horsemen of Social Media: Fear,

Control, and Trust (Hinchcliffe, 2009). How many times, when something like social media is brought up (and it must have happened when e-mail was dawning), do we hear objections such as, What if people say the wrong things? What if people say secret things? What if people say bad things? All of these statements indicate some level of fear of the vulnerabilities that these new technologies would launch into the workplace. The only problem? They're wrong—and they ignore the tangible and intangible costs of a missed opportunity.

The reason these objections are a collective red herring is that social media actually do not create any of these as new vulnerabilities. If employees have e-mail and phones or even access to copy machines, the ability and vulnerability for them to create mass havoc already exists.

The First Horseman: Fear

Consider the story of Pandora's box (Wikipedia, n.d.). Pandora is given a box and told not to open it. Her curiosity overcomes her though, and she opens the box and releases all the ills of the world. The end of the story, however, is often left out. Pandora does manage to shut the box again, trapping only hope inside. This is exactly what the fear of social media is doing. By not going forward, albeit prudently and thoughtfully, the acquisition workforce is not managing to prevent any new vulnerabilities. Rather, they are simply managing to keep out the very capabilities—increased sharing of knowledge and increased collaboration—that could actually mitigate some existing vulnerabilities. Even the defense intelligence community is recognizing and embracing that dynamic.

The Second Horseman: Control

The second anxiety-causing dynamic relates to control. The defense acquisition workforce and its managers have always thought (and taught) that tighter and tighter control would help everyone "stay on message"; social media destroys that paradigm. What social media teaches is that to control or shape the message, one actually has to participate in the discussion.

One of the best examples of this is a blog written by Bob Lutz, the vice chairman for General Motors. Lutz started the blog about GM cars called the FastLane Blog (Lutz, 2009). When it debuted, readers seriously doubted if Lutz was really writing it. He eventually confirmed it was really him, and managed to start an authentic conversation with GM customers. Regardless of what happened to the company from a financial standpoint, Lutz realized that press releases just did not convince anyone of anything. Therefore, to shape the conversation about GM cars, he gave up the

mythical control of only releasing "approved" content and acting like people were not talking about GM cars anyway—and simply jumped into the thick of things.

The current Chairman of the Joint Chiefs of Staff is on Facebook and Twitter (Facebook, 2009); and the Chief Information Officer of the Department of the Navy blogs (CHINFO, 2009). They do these things for several reasons, but one is to shape the conversation by being part of it.

The Third Horseman: Trust

The final and third horseman is Trust. This is possibly the most powerful of all three—it asks the defense acquisition workforce management to look at the people they have hired and upon whom they rely for the day-to-day operations of Project Management Offices (PMOs) and Major Defense Acquisition Programs (MDAPs). Not only are managers to look at their workforce, but actually articulate how much they trust them. What message is being sent if managers trust their acquisition workforce to manage millions of taxpayer dollars, but do not trust them to refrain from using Twitter at work? Consider that these same employees are trusted to make acquisition program decisions that will affect the lives of thousands of soldiers, while managers may be reluctant to allow editing of documents collaboratively. In one sense, what this boils down to is: What kind of culture do we believe we have? Henry Jenkins, an author and MIT professor, writes about one such culture that the defense acquisition workforce may do well to look toward—a participatory culture.

> A participatory culture is a culture with relatively low barriers to expression and engagement, strong support for creating and sharing, and some type of informal mentorship whereby what is known by the most experienced is passed along to the novices. (Jenkins 2009).

This is the kind of culture that would seem to value and promote trust among employees and between supervisors, leadership, management, and their employees on the front lines executing their direction. Make no mistake: Fear, Control, and Trust are all issues that must be dealt with to successfully exploit the rich capabilities that social media offer us.

Again, the quote that began this article speaks to the need to avoid assumptions of the past in order to move forward; do not discount this in dealing with the three horsemen—their power to restrain us lies as much within our organizational designs as any real or realized problem or vulnerability. Bill Gates, speaking in 2005 to the National Governor's Association, had a similar warning. The topic was education but the message was just as clear. He asserted that:

> America's high schools are obsolete. By obsolete, I don't just mean that our high schools are broken, flawed, and under-funded—though a case could be made for every one of those points. By obsolete, I mean that our high schools—even when they're working exactly as designed—cannot teach our kids what they need to know today. Training the workforce of tomorrow with the high schools of today is like trying to teach kids about today's computers on a 50-year-old mainframe. It's the wrong tool for the times. (Gates, 2005)

Those of us who work in training and education within DoD need to share a similar concern. The argument is not that all we do is obsolete; the argument is that unless we adapt, improvise, and overcome our issues with regard to Fear, Control, and Trust within our own organizations, we may well be sustaining a model that is functioning perfectly as designed, but the design itself may be insufficient for current and emerging requirements.

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Mr. Mark Oehlert is a recognized expert, author, and speaker in the fields of innovation, emerging technology, and game-based learning. He has worked in the e-Learning field for 10 years, bringing his unique insight as a trained historian and anthropologist to a range of challenges from performance support to mobile computing and learning strategy development. Mr. Oehlert now serves as an innovation evangelist at the Defense Acquisition University.

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FIGURE 4. RISK MATRIX

Category	Risk (RIN)	Mitigation (Handling)	Metric (Monitoring)	Risk Status	Risk Assessment
Supportability (Low/Moderate)	FSR Support • Ability to support full Army fielding IAW PM Support concept (multifunctional FSRs) • Stovepipe support structure • Incorporation of FSR Experience into Design Process • Downsizing of FSR Personnel	Simplify/Stabilize SW Automate maintenance function Cross-functional FSRs across BC Dev existing BC support base for CPOF Integrate into the Army Support Structure	FSR/Unit (DIV/BDE/BN, etc) Data Integration for Reporting and Reuse	The System of System (SoS) Migration Plan Implementation and the mandated FSR reduction requirement for FY08 drives this risk.	
	Software Supportability/Efficiency • Ability for CPOF software to aid in and provide a Stable CPOF Network • Ability for CPOF to be upgraded and fixed as needed, on the fly and from a remote location. • SW Documentation • CM Processes • Garbage Collection • 64 Bit Backup Processes	Deploying 'SuperTech' developer to theater Implementation of Development Crisis Team Develop remote admin and distribution capabilities	Computer Resource Utilization/Available SW Quality Level Used Standards Metric Reliability (Fault Tolerance, recoverability) Maintainability (Stability, changeability) Operational Ability (Ao)	Current development tasks are designed to increase the ability of the baseline 3.0.2 Software to aid in the supportability area. Development remains on track but the technical difficulty of implementation drives this risk to be moderate.	
	Hardware Support & Acquisition Processes • Hardware Availability and Lead Time to support on-going ops • End of Life • Maintain multiple configurations	Buffer Supply of hardware to deploy as needed Leave behind hardware in Theater for next units to fall in on Use Spares to fill in gaps until hardware arrives UID CM Process, Documentation and Enforcement	Estimated vs. Actual Delivery Times Maintenance Downtime Repair Cycle Time Parts Availability	Contact is in place for the acquisition of hardware and support. The implementation of a Configuration Management process will be in place by FY07 thus helping reduce the risk.	
	Training • Training structures integrated into mainstream Battle Command Support Structures	Inclusion of an embedded trainer. Training and Support package for NET, TRADOC and Sustainment	Actual vs. Planned # of personnel attending Training Systems Available Student Proficiency /Skill Level Training Level vs. Proficiency	Logistics Products are currently being developed to improve current training and to meet the First Unit Equipped Date (FUED).	
Technical (Moderate)	• Incompatible Versions of Fielded Software • Bug Fixes and Patch Upgrades • Inadequate Evaluation of SW	Implementation of Multiple CPOF Networks PASS to Exchange Information Field New Units CONUS Evaluate and Determine Criticality of Bug Fixes and Patches. If possible Roll Up to decrease system upgrade times. Remote Admin push of small critical updates	# and Version Type of CPOF Networks # of Total SW Bugs vs. # Critical SW Bugs Percentage of Total Critical Bugs Fixed	Currently, Bugs are identified, evaluated and rolled up into fixes and patches based on prime 's processes. New implementation calls for GOV approval and structuring of Patches, Fixes and Smaller Releases to allow for identification of critical elements and establishment of acceptable timeframes.	
	Current Software Limitations • No Full spectrum Ops • No Ruggedization • Limited Interoperability • Theater Requested Enhancements • Marine Requested Enhancements	Expectation Management Customer Awareness Evaluate and Implement Important Theater/Marine Requests using out Quick Reaction Theater Development Support and Prime SW Development Team	# Theater/Marine Requests Outstanding Average Implementation Time of Theater/Marine Requests	Currently CPOF Block 2 Requirements do not provide complete Full Spectrum Capability to the Warfighter. Currently effective customer management by PO and FSR Personnel help to give Customers an understanding of when capability will become available. Most new requirements are processed and approved by the TSM.	

FIGURE 4. RISK MATRIX

Category	Risk (RIN)	Mitigation (Handling)	Metric (Monitoring)	Risk Status	Risk Assessment
Supportability (Low/Moderate)	FSR Support • Ability to support full Army fielding IAW PM Support concept (multifunctional FSRs) • Stovepipe support structure • Incorporation of FSR Experience into Design Process • Downsizing of FSR Personnel	Simplify/Stabilize SW Automate maintenance function Cross-functional FSRs across BC Dev existing BC support base for CPOF Integrate into the Army Support Structure	FSR/Unit (DIV/BDE/BN, etc) Data Integration for Reporting and Reuse	The System of System (SoS) Migration Plan implementation and the mandated FSR reduction requirement for FY08 drives this risk.	
	Software Supportability/Efficiency • Ability for CPOF software to aid in and provide a Stable CPOF Network • Ability for CPOF to be upgraded and fixed as needed, on the fly and from a remote location • SW Documentation • CM Processes • Garbage Collection • 64 Bit Backup Processes	Deploying 'SuperTech' developer to theater Implementation of Development Cross Team Develop remote admin and distribution capabilities	Computer Resource Utilization/Available SW Quality Level Used Standards Metric Reliability (Fault Tolerance, recoverability) Maintainability (Stability, changeability) Operational Ability (Ao)	Current development tasks are designed to increase the ability of the baseline 3.0.2 Software to aid in the supportability area. Development remains on track but the technical difficulty of implementation drives this risk to be moderate	
	Hardware Support & Acquisition Processes • Hardware Availability and Lead Time to support on-going ops • End of Life • Maintain multiple configurations	Buffer Supply of hardware to deploy as needed Leave behind hardware in Theater for next units to fall in on Use Spares to fill in gaps until hardware arrives UID CM Policies, Documentation and Enforcement	Estimated Vs. Actual Delivery Times Maintenance Downtime Repair Cycle Time Parts Availability	Contract is in place for the acquisition of hardware and support. The implementation of a Configuration Management process will be in place by FY07 thus helping reduce the risk.	
	Training • Training structures integrated into mainstream Battle Command Support Structures	Inclusion of an embedded trainer. Training and Support package for NET, TRADOC and Sustainment	Actual vs. Planned # of personnel attending Training Systems Available Student Proficiency /Skill Level Training Level vs. Proficiency	Logistics Products are currently being developed to improve current training and to meet the First Unit Equipped Date (FUED)	
Technical (Moderate)	• Incompatible Versions of Fielded Software • Bug Fixes and Patch Upgrades • Inadequate Evaluation of SW	Implementation of Multiple CPOF Networks PASS to Exchange information Field New Units CONUS Evaluate and Determine Criticality of Bug Fixes and Patches. If possible Roll Up to decrease system upgrade times. Remote Admin push of small critical updates	# and Version Type of CPOF Networks # of Total SW Bugs vs. # Critical SW Bugs Percentage of Total Critical Bugs Fixed	Currently Bugs are identified, evaluated and rolled up into fixes and patches based on [illegible] processes. New implementation calls for GOV approval and structuring of Patches, Fixes and Smaller Releases to allow for identification of critical elements and establishment of acceptable timeframes.	
	Current Software Limitations • No Full spectrum Ops • No Ruggedization • Limited Interoperability • Theater Requested Enhancements • Marine Requested Enhancements	Expectation Management Customer Awareness Evaluate and Implement Important Theater/Marine Requests using our Quick Reaction Theater Development Support and Prime SW Development Team	# Theater/Marine Requests Outstanding Average Implementation Time of Theater/Marine Requests	Currently CPOF Block 2 Requirements do not provide complete Full Spectrum Capability to the Warfighter. Currently effective customer management by PO and FSR Personnel [illegible] to give Customers an understanding of when capability will become available. Most new requirements are proposed and approved by the [illegible]